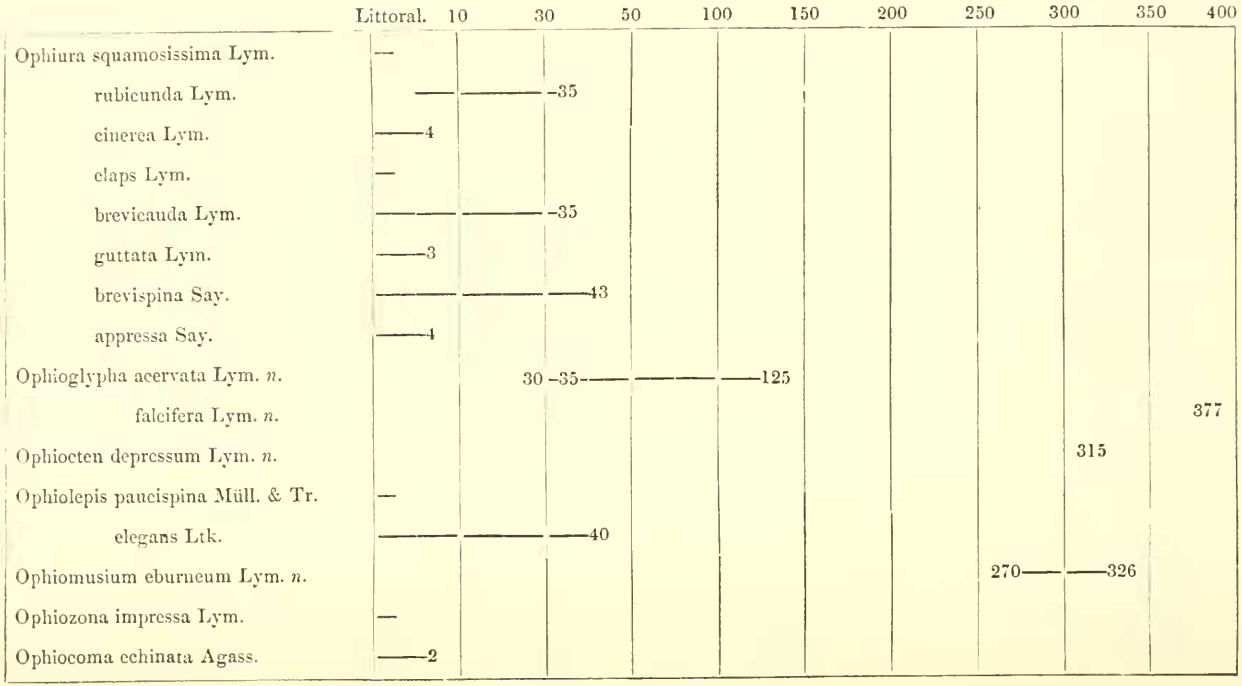
No. 10. — *Preliminary Report on the Ophiuridæ and Astrophytidæ dredged in deep water between Cuba and the Florida Reef, by* L. F. de Pourtales, Assist. U. S. Coast Survey. Prepared by Theodore Lyman.

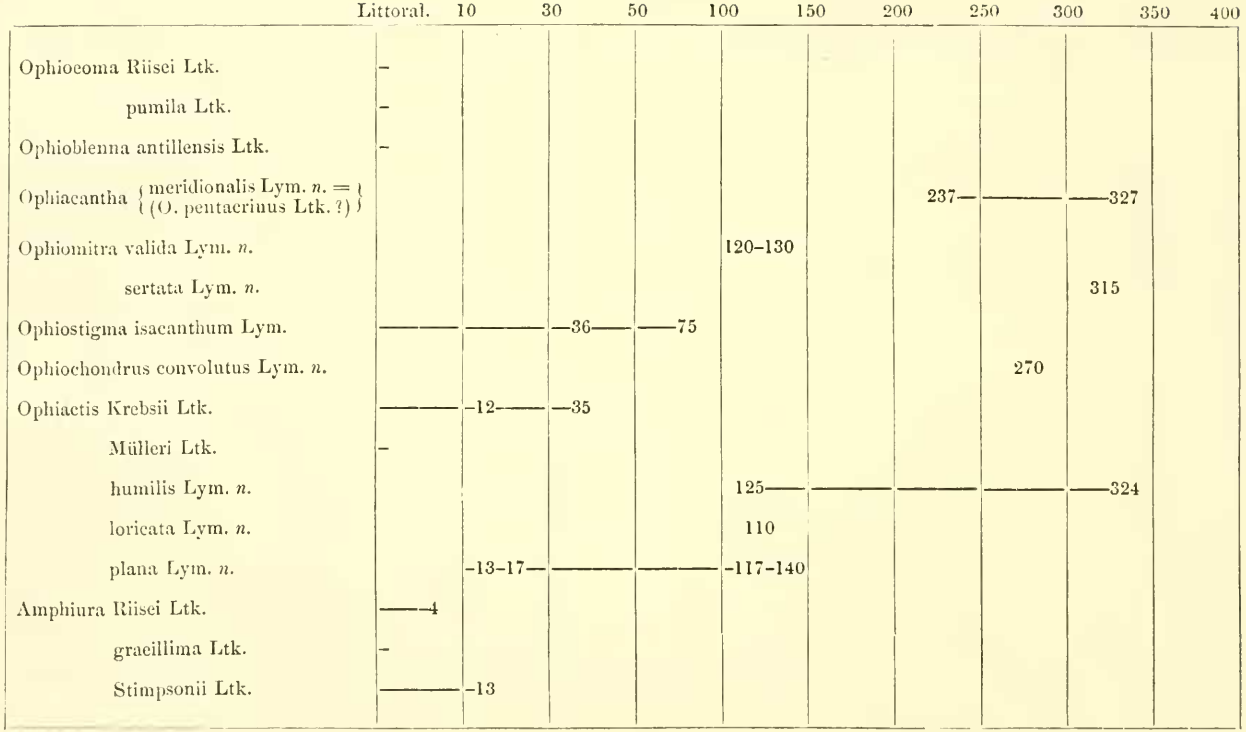
(Communicated by Professor B. Peirce, Sup't U. S. Coast Survey.)

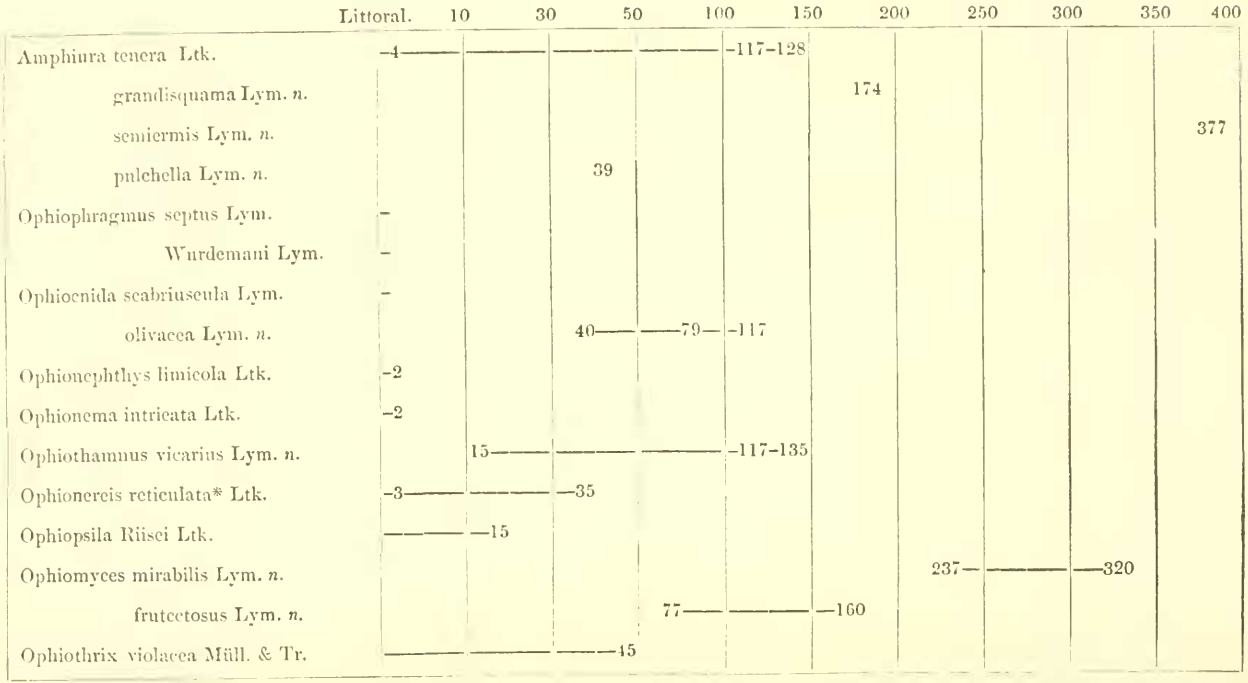
I. *General Remarks.*

From the small circle of the Caribbean waters there are now known sixty-three species of Ophiurans and Astrophytons, nearly all of which are critically determined. The standard work of Müller and Troschel, published in 1842, did not contain a greater number of well-defined species from the whole world! Considering their number and their bathymetric range (which goes nearly to 400 fathoms) we are justified in looking upon their faunal data as of real importance. First, then, considered within their own peculiar sea dominion, to what depths do these species descend, and to what shallows do they rise? A glance at the following table will reply. Those species with which naturalists have been most familiar as "West Indian" are pretty much *littoral*. The abundant forms of *Ophiocoma echinata*, *Ophiura cinerea*, *Ophiactis Mülleri*, &c., swarm among the sponges and madrepores of the warm shallows. A few descend to 35 or 40 fathoms, as if to reach a hand to their deep-sea relations; such are *Ophiura brevispina* and *Ophiolepis elegans;* there are even two, *Ophiostigma isacanthum* and *Amphiura tenera*, that have been found respectively at 75 and 128 fathoms. But these are exceptions, for if the dredge sometimes brings up a littoral brittle-star, it is a straggler and not an inhabitant. Between 15 and 75 fathoms there is a mixed region where dwell the more venturesome of the littoral species and certain new-comers, that either recall the European fauna (*Ophioglypha acerrata*) or seem a continuation of the littoral types (*Ophiactis plana*, *Ophiocnida olivacea*). It is below 100 and even 200 fathoms that the really *new* types are found. The seven new genera herein described have all a maximum depth of more than 100 fathoms, and only one, *Ophiothamnus*, runs into less than 75 fathoms. All the species below 250 fathoms are either of new genera, or are singular forms of old genera (*Ophioglypha falcifera*,

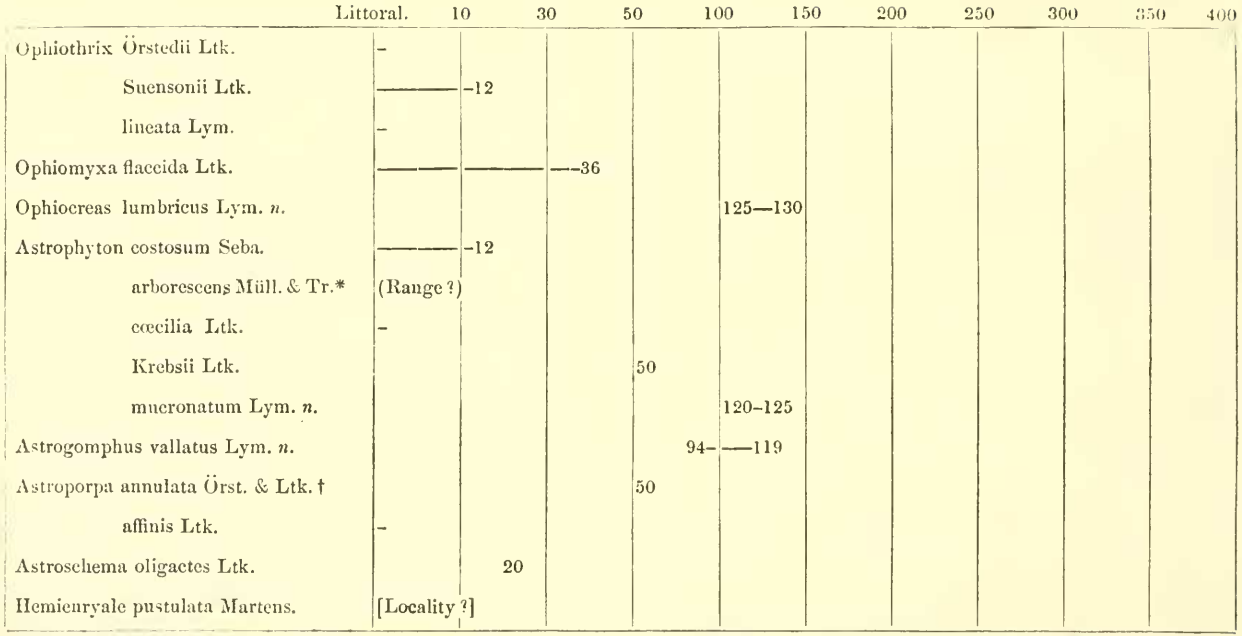
The *horizontal* lines show the range of the species in depth.




Littoral.
10
30
50
100
150
200
250
300
350
400
Ophioeoma Riisei Ltk.
pumila Ltk.
Ophioblenna antillensis Ltk.
Ophiacantha { meridionalis Lym. n. = (O. pentacrinus Ltk. ?) }
237—
—327
Ophiomitra valida Lym. n.
120–130
sertata Lym. n.
315
Ophiostigma isacanthum Lym.
—36—
—75
Ophiochondrus convolutus Lym. n.
270
Ophiactis Krebsii Ltk.
–12—
—35
Mülleri Ltk.
humilis Lym. n.
125—
—324
loricata Lym. n.
110
plana Lym. n.
–13–17—
–117–140
Amphiura Riisei Ltk.
—4
graeillima Ltk.
Stimpsonii Ltk.
–13



* Prof. Verrill has shown (Proceed. Boston Soc. Nat. Hist XII, 381, 1869) that *O. porrecta* is from the Pacific islands. I am therefore inclined to think that this species, with *O. crassispina* Ljn. and *O. squamata* Ljn., may all be synonymes of *O. dubia* Lym. (Savigni, Descr. de l'Egypte, 1809, Pl. I, Figs. 3 to 3[10]).



* At the Jardin des Plantes are two Astrophytons, brought the one from the Antilles by Maugé, 1799; the other from Guadaloupe, by Beaupertuis, 1837. They are of the same species; and I could detect no difference between them and a specimen of *A. arborescens* from the Mediterranean.

† Dujardin and Hupé (Hist. Nat. des Zoophytes, 1862) speak of *Astroporpa dasycladia*, in the Jardin des Plantes, as a new species. I saw these specimens in 1861, and they are nothing but *A. annulata*; also their *Astroschema affinis* is too dubious to be admitted.

Ophiactis humilis, &c.). If, therefore, these zones of sea bottom were to-morrow turned to stone, we should find a certain separation of species, but there would be *overlapping* species that would connect the fossils, as of one formation. Such are the *vertical* relations. The horizontal relations can only partially be known, except in the direction of the European coast, because there have been no considerable dredgings on the American side, either to the north or the south, and comparisons must be made only with the littoral forms. It is well known that a few of the Florida Ophiurans (*Ophiactis Krebsii*, *Ophiolepis elegans*, &c.) have been found as far as Charleston, S. C., while in the direction of Brazil many species are found (*Ophiomyxa flaccida*, *Ophiactis Krebsii*, *Ophionereis reticulata*, *Ophiothrix violacea*, *Ophiolepis paucispina*, *Ophiura cinerea*, *O. appressa*, *Amphiura Riisei*, *Ophiopsila Riisei*). One species, *Hemipholis cordifera*, has been collected in Charleston and in Rio, but not yet between those points.

Naturalists seem to overlook the fact, that, although the edges of the Caribbean fauna spread thus wide, they encounter two other faunæ, north and south. At Charleston, *Ophiothrix angulata* and *Amphiura atra* are forms not seen on the Florida coast, while at Rio the *Ophiura Januarii*, *Ophioceramis Januarii*, and several species of *Amphiura* attest a region of new marine life. It is already well known that the littoral Ophiuran faunæ of North and Middle Europe and the Gulf of Mexico are not comparable with each other, even the genera being often different. How is it with the deep-sea forms? One species is *identical*, — *Ophiomyces frutectosus*, — and this, strangely enough, was never seen by human eye until within a few months. Two other species *may* be identical, — *Astrophyton arborescens* and *Amphiura tenera* (= *elegans*?). One species is, in the true sense, *representative*, — *Ophioglypha acervata* (comp. *O. albida*). The remaining fifty-nine species are, so far as we now know, Caribbean. As to the Panama fauna, the similarity between the opposite sides of the Isthmus has already been shown by Lütken, Verrill, and myself. The correspondence of the twelve twin species shown in the following table is something more than casual: —

Caribbean Fauna.	Panama Fauna.
Ophiura cinerea Lym.	Ophiura teres Lym.
Ophiolepis elegans Ltk.	Ophiolepis variegata Ltk.

Caribbean Fauna.	Panama Fauna.
Ophiozona impressa Lym.	Ophiozona pacifica Lym.
Ophiocoma pumila Ltk.	Ophiocoma Alexandri Lym.
Ophiactis Krebsii Ltk.	Ophiactis virescens Örst. and Ltk.
Amphiura tenera Ltk.	Amphiura violacea Ltk. " puntarenæ Ltk. " microdiscus Ltk.
Amphiura Riisei Ltk.	Amphiura grisea Ljn.
Ophiophragmus septus Lym.	Ophiophragmus marginatus Lym.
Ophiocnida scabriuscula Lym.	Ophiocnida hispida Lym.
Hemipholis cordifera Lym.	Hemipholis affinis Ljn.
Ophionereis reticulata Ltk.	Ophionereis annulata Lym.
Ophiothrix violacea M. and T.	Ophiothrix spiculata LeC.

How is it that the vast Pacific fauna, common to the waters between Zanzibar and the Sandwich Islands and between Loo Choo and the Kingsmill group, changes its character near Panama, and takes on a *partial* Caribbean form? We might think that the mingling of the two oceans, before the upheaval of the isthmus, was the origin, and that the differences between these species was the measure of their variation since the cretaceous period. But then the Caribbean forms appear on the Pacific side, while the Pacific forms seem not to come over; and no matter whether there is or is not a difference of level between the oceans, it would scarcely have availed to prevent a mixture in *both* directions by storms, or by currents. It is also perfectly credible that water-birds should mix the faunæ across an isthmus which has a minimum width of twenty-eight miles, just as they convey fish eggs to distant and isolated ponds. But again there is the same objection as before. I must therefore content myself with saying that of these twelve pairs of species there are several that would probably be considered only as *varieties*, if they lived in the same waters. Speculation is, after all, of small value, because the facts are insufficient, and because there is a prospect of getting many more facts. For example, all the diligent dredging on the European coasts had failed to show a species of brittle-star identical with the Caribbean; but, almost at the same time, two expeditions bring up, from a depth of only 75 fathoms, a species new to science and common to the two sides of the warm Atlantic. Such is the value of negative evidence!

II. *Descriptions of New Genera and Species, with Critical Remarks.*

Here follow descriptions of seven new genera and twenty-one new species. There were, besides, two specimens of *Ophiothrix*, brought up from 110 and 206 fathoms. The one had the disk completely hidden by little thorny stumps, showing only the points of the radial shields; the arm-spines were long, slim, and very jagged; the other specimen had a small, compact disk, with naked radial shields spotted with green, and green cross lines on the arms; in the centre of the disk, spines; arm-spines short and very jagged. Both were young, and I did not choose to add to the present complication of this difficult genus by describing them. The *Ophiothrix violacea* displays certain variations at a depth that are not seen in shallows, but I believe the species is the same. There also were two species of *Amphiura*, probably new, but too imperfect to describe; and one soft-bodied little thing that may be the young of *Ophiomitra*, or may be new.

OPHIURIDÆ.

Ophioglypha acervata Lyman, sp. nov.

Special Marks. — Three arm-spines of unequal lengths; the middle one commonly shortest; towards the tip of the arm the spines are longer as compared with the side arm-plates. Under arm-plates with a peak or point without. Those papillæ of the "arm-comb," which are beneath the disk, are flat and square, so as to form an even close-set row.

Description of a Specimen. — Diameter of disk 9 mm. Length of arm (broken) about 40 mm.* Mouth papillæ seven to each angle, of which the innermost is central, lying just below the teeth, and of similar form, so that it might as properly be considered a true tooth; the mouth-papilla on each side is of the same shape, but the two outer ones are flattened, angular, much wider than long, with a cutting edge re-enteringly curved, or notched. Teeth three, four, or even five, shaped like a blunt spear-head, swelling in the middle, and rounded. Mouth-shields as long as broad; broader without than within; outer side cleanly curved, inner side making an angle; length to breadth 1.8 : 1.8. Side mouth-shields narrow, and of equal width, meeting within, and thence running along the inner angle of the mouth-shield to the head of the genital slit. First under arm-plate as

* The arm is doubtless much longer than this, usually. In some smaller specimens it ran out in a thread-like way, something after the manner of *O. robusta*.

large as any; broader than long; of a rounded diamond-shape, with a distinct, rounded peak without; length to breadth .6 : .9. Second plate touching the first; third plate barely separated from the second by the juncture of the under arm-plates; fourth plate well separated from its successor, as are all those beyond. Fifth plate bounded within by two re-entering curves, which come to a point on the median line; without, it has a little peak in the centre which gives it a faintly *tri-lobed* appearance; the laterals are short and straight; length to breadth .5 : .8. The plates beyond this one have a similar form, but continually grow smaller by the increased encroachment of the side arm-plates. Side arm-plates meet below at the third under arm-plate; and, above, at the ninth upper arm-plate: their upper edges are re-enteringly curved, which gives a peculiar shape to the upper arm-plates. These last are, near the disk, broader without than within, with a strongly curved and thickened outer side; and their laterals are curved by reason of the peculiar form of the side-plates; further out, where they do not touch each other, they come to a point, within; length to breadth (sixth plate) .8 : .7. Disk, above, covered with crowded, irregular, flattened scales, none of which are much swelled, so that the surface is nearly smooth. The primary plates are not conspicuous either by size or thickness, except the central one, which is very distinct, nearly round, and .6 mm. in diameter. Radial shields large, thick, and conspicuous; irregular pear-seed shape, and strongly diverging; length to breadth 2 : 1.4; they are entirely separated by a very irregular wedge of scales, which sometimes consists of a double row; sometimes of a mixture of a single and double row, respectively of larger and smaller scales. The large, thick radial-scales carry all the papillæ of the arm-comb, which are about twenty in number on each side and of two sorts; those seen from above are sharp and diverge from each other; those seen from below are flat and square, so as to form an even, close-set row; there are about ten of each kind, and those at the ends of the row differ most. The arm-comb is continued, along the edge of the genital slit, by a row of about seventeen very fine papillæ. On the upper arm-plates within the notch is a row of fine papillæ corresponding to those of the arm-comb. The scales of the interbrachial spaces below are thin and crowded. Arm-spines cylindrical, blunt, scarcely tapering; lengths to that of the under arm-plate (eighth joint) .4, .2, .3 : .5. Further out on the arm they are proportionately much longer, and towards the last third of the length the lowest spine is nearly or quite as long as the side arm-plate; there, also, they are more slender, and taper to a fine point. Twelve tentacle scales on the first pore, seven being on the side next the interbrachial space; six scales on the second pore; five on the third; four on the fourth; three on the fifth; two on the sixth; and one scale on the joints beyond that.

Color, in alcohol, light gray.

Variations. — A specimen with a disk of 6 mm. had the arm-spines nearly equal (the lowest rather shortest), and three fourths as long as the side arm-plate. In general the middle spine is shortest, but in a considerable series examined numerous variations were to be seen; rarely, the spines on some part of the arm were equal; yet, even then, they would be of unequal lengths on other parts. A specimen with a disk of 3 mm., had the under arm-plates comparatively smaller, but still exhibiting in one way or another the characteristic peak or lobe on the outer side; the fourth plate was broad, regular, heart-shape, but with a little point within where the outer sides of the side arm-plates joined on the median line; the tenth plate was similar, but the outer side being wavy gave greater distinctness to the little lobe; on the upper surface of the disk, a greater proportionate space was occupied by the primary plates, though none of them touched each other; the radial shields were quite separated by two large rounded plates; the notch of the disk only included a part of one upper arm-plate, and the side arm-plates met above, at the third joint from the disk. In a very young specimen, having a disk only 1 mm. in diameter, nearly all the surface of the upper disk was covered by six large, round primary plates, one in the centre and one opposite each arm; immediately round the centre plate were five small ones, situated opposite the interbrachial spaces; over each arm were two very small radial shields like scales, and, in the interbrachial space, on the edge of the disk, a large plate; finally, there was one more small plate in each interbrachial space, making a total of thirty-one pieces. The notch of the disc was scarcely indicated, and there was no arm-comb. Below, the interbrachial spaces were almost filled by the mouth-shields. The side arm-plates bore three short spines about one third the length of the joint resembling those of *O. albida*, and met both above and below, on all the joints; although the upper and lower arm-plates were well defined and had nearly their true shapes.

This species, brought up in numbers from 30 to 125 fathoms, is of high interest; first, because it seems not to live in company of any species of the same genus; and secondly, because it much resembles *Ophioglypha albida*, so widely distributed in the North European seas and in the Mediterranean. It is, however, distinguished by the different form of the arm-spines, arm-comb, and under arm-plates. *Ophioglypha Grubei* has very similar under arm-plates (if Heller's drawing is accurate),* but differs in the arm-spines and in the curious swelling of the upper arm-plates. Mr. Ljungman kindly examined the specimens and decided that they did not agree with any of the numerous varieties of *O. albida*, with which he is familiar He also

* Sitzungsb. der Kais. Akad. der Wissens. XLVI, p. 415, pl. II, figs. 13–16.

stated that *O. Grubei* was only a variety. I examined specimens of *O. albida* dredged by the "Josephine" at the Azores, and they were as different from *O. acercata* as those of Scandinavia.

Several localities, in from 30 to 125 fathoms.

Ophioglypha falcifera LYMAN, sp. nov.

Special Marks. — Three arm-spines, the middle one is a strong hook, turned upwards. Arm-comb single, running along the genital plate and along the outer edge of radial shield, above the arm.

Description of Specimen. — Disk 4.5 mm. Arm 10 mm. Width of arm, 1 mm. Mouth-papillæ very short and broad and so closely soldered as to appear like a plain line; usually, however, there may be distinguished four on each side, of which the two outer are longest; besides these, there is a central, inner one, not soldered with the rest, having a blunt diamond shape, somewhat like the teeth, under which it lies.

Mouth-shields rounded heart-shape, with a wide curve without, and a decided obtuse angle within; length to breadth 1.1 : .8. Side mouth-shields rather narrow, meeting within, and extending outwards to the lateral corner of the mouth-shield. Under arm-plates, near base of arm, as long as, or longer than, broad; much wider without than within; bounded without by a curve, within by a small angle whose sides are re-entering curves, and on the sides by re-entering curves; a little further out the curves of the inner angle and of the side of the plate are blended in one, and the plate then resembles a broad wedge with curved outlines. This wedge widens and shortens as it is found further out on the arm, so that, near the end, it consists of a very obtuse angle without, and of a wavy border within, having a little central peak; length to breadth (4th joint) .4 : .4. Side arm-plates meeting everywhere below, and also above, beyond the first joint from the disk. Their line of juncture at the fourth joint is equal to half the length of the under arm-plate; the total length of the joint being .6 mm. This proportion rapidly increases, and, near end of arm, this line is double or treble the length of the under arm-plate. Upper arm-plates fan-shape, bounded without by a curve and within by two re-entering curves, which meet on the median line; length to breadth .4 : .5. Disk covered above by numerous rounded scales in concentric rows, each row standing higher than that outside; the central primary plate is highest of all, and has a diameter of .8 mm. Among these are a few smaller, irregular scales. There are three of these concentric circles, whereof the outermost includes the radial shields, which are of a rude pear-seed form, touching near their outer third, so that they diverge widely within, and less widely without, forming a notch in the disk which includes part of an upper arm-plate; length to breadth .8 : .8. They are separated within by part of a large scale, which has a rude diamond

form. Below, the disk is covered by half a dozen plates, in each interbrachial space, arranged in two concentric rows; besides which a wide genital plate runs along the slit, bearing on its edge a row of short, stout, rounded papillæ, which run from the second under arm-plate upwards along the outer edge of the radial shield to a point about opposite the lateral corner of the upper arm-plate. Arm-spines three, very short and small; lengths to that of under arm-plate (3d joint) .2, .2, .2 : .4. At, and beyond the first joint outside the disk, the middle spine takes on the form of a broad, strong hook, having two curved teeth on the upper edge. At the tip of the arm there are but two spines, of which the upper is the hook. Tentacle scales of the mouth-tentacles six; three on each side of a very narrow incision, which is squeezed between the side mouth-shield (which bears three of the scales) on one side, and the large first under arm-plate and the outermost mouth-papilla on the other side. Second pore with six scales, arranged round a narrow oval; third pore, two scales, side by side; and those beyond, only one scale, which, at some distance out on the arm, is very minute and difficult to be seen.

Color, in alcohol, white.

Variations. — Another smaller specimen had the disk 3 mm. and the arm 9 mm. The mouth-shields were proportionately longer than in the first mentioned, — a variation common to the whole genus.

Two specimens, in 377 fathoms, south of Rebecca Channel.

The plates on the disk indicate that these specimens, although by no means fully grown, are yet large enough to show the adult characters. Thus *O. Sarsii*, with a disk of 4.5 mm. (see Lütken Addit. ad Hist. Oph. Pt. I, Pl. I, fig. 3), is more *young*, in this respect, than *O. falcifera*, and yet has taken on all the parts needed for ready recognition of the species. We may look for an adult of this curious species about the size of *O. Sarsii*, or rather smaller, and having a large number of small plates on the disk. The stout, double-toothed hook, as a middle arm-spine, is only an embryonic organ carried forward. In the very tip of the arm of *O. acervata* I have found, on the last fourteen joints, only two spines; and of these the upper one was flattened, and bore on its *upper* edge (just as in *O. falcifera*) about nine microscopic, hooked teeth. It may be that the fully grown *O. falcifera* has the middle hook, at the base of the arm, so overgrown as to form a stumpy spine.

Ophiocten depressum Lyman, sp. nov. *

Special marks. — Disk very thin and flat, with a sharp edge. The granules of the disk are numerous, but irregularly scattered; none on the

* This species departs a good deal from the typical *Ophiocten*. The disk granulation is not continuous, but scattered; there are no combs of spines on the outer edges of the

interbrachial species, below. A row of papillæ along the outer end of the radial shield and the edge of the disk. Two arm-spines.

Description of a Specimen. — Diameter of disk 8 mm. Length of arm (broken) about 50 mm. Mouth-papillæ seventeen to twenty-one to each angle: of these, usually three are rounded, tapering, spear-head shape, and point to the centre of the mouth, being placed at the apex of the angle; the remainder are much smaller, and are flat and squarish; they form a connected row, the two outermost usually borne on the edge of the side mouth-shield, the remainder on the mouth-frames. Teeth, four; flat, delicate, long, and tapering to a point. Mouth-shields broad, rounded heart-shape, with a little peak within. Side mouth-shields long and narrow; they begin at the junction of the first under arm-plate with the side arm-plate of the second joint, and run thence across the end of the genital slit, meeting nearly, or quite, at the inner point of the mouth-shield. Under arm-plates in contact with each other along the whole basal part of the arm. First plate small, round hexagonal, longer than broad, and wedged between the outer ends of the neighboring side mouth-shields. Second plate narrowed within, and bounded by six sides; as follows: outer side nearly straight; laterals short and straight; inner laterals re-enteringly curved, to admit the large tentacle pores, and converging on the inner side, which is straight and very short. Fifth plate as broad as long; outer side slightly re-enteringly curved; inner side a little curved; laterals nearly straight, inner laterals short, and a little re-enteringly curved; length to breadth .6 : .6. Two thirds out on the arm, the side arm-plates meet below, along a line about one-half as long as the under arm-plate, which is there triangular, with its sides a little curved, and the apex directed inward. Side arm-plates robust, but not meeting below or above till near the end of the arm. Upper arm-plates four-sided, broader than long; outer side curved; inner side re-enteringly curved; laterals straight; length to breadth (4th plate) .6 : .8. The first upper arm-plate is very small, and fits in the little notch made by the outer ends of the radial shields. Two thirds out on the arm the plates have the same form, though much more elongated. Disk covered, above and below, with numerous rather large plates of very irregular outline, all of which, except those of the lower surface, are more or less studded with small, smooth granules; on the under surface is an irregular double row of granules, extending round the inner end of the genital slit, and along the genital plates as far as the third joint of the arm: a row of large granules, or short, stout papillæ, runs along the edge of the

basal upper arm-plates; the arm-comb of papillæ is continued along the edge of the disk; the side arm-plates do not join below; the first pair of pores of the arm-tentacles are surrounded by scales. Nevertheless, I am not clear enough as to the generic differences in this group to make a separation.

disk, and over the arm on the outer edge of the radial shield. The edge of the disk, in each interbrachial space, is composed above of three plates, and below of six.

Radial shields, of a very irregular triangular form, with the point inward; they nearly, or quite, touch without, but immediately diverge and are separated by a wedge of one small, one large, and part of another large plate; length to breadth 1.5 : .8. Two small, rounded, tapering arm-spines; the lower slightly longer; lengths to that of under arm-plates (5th joint) .4, .5 : .6. Tentacle scales, on second joint, six to each pore, arranged in an oval, three on each side; on third joint, two, arranged side by side; on joints beyond that, one. They all have the same shape of a small, thickened scale, but those towards tip of arm are proportionately larger. The mouth tentacles, of the first joint, have scales on either side, in form of an incision, somewhat as in *Ophioglypha:* on the side next the jaw, the two mouth-papillæ that stand on the side arm-plate are tentacle scales; and, on the side next the mouth slit, there are two more, which stand on a little plate, the homologue of a side arm-plate, running upwards into the mouth slit from the first under arm-plate.

Color, in alcohol, light brown.

Two specimens, off Double-headed Shot Keys, in 315 fathoms.

Ophiomusium, gen. nov.*

Teeth: no tooth-papillæ; mouth-papillæ soldered in a continuous row, so that their former outlines are scarcely to be seen. Disk covered by plates and radial shields, all of which are intimately soldered, forming a surface like porcelain. Upper and under arm-plates minute: side arm-plates meeting above and below; swelled, intimately soldered with the neighboring parts. No tentacle pores beyond the basal arm-joints. Small arm-spines on outer edge of arm-plates. Two genital slits in each interbrachial space.

In the nature of its covering, this singular genus has some affinity with *Ophiolepis*, as now restricted. But it is unique in having no tentacle pores on the greater part of the arm.

Ophiomusium eburneum Lyman, sp. nov.

Special Marks. — Two very small, blunt arm-spines, less than one third as long as the arm-joint. No tentacles beyond the first two joints. Surface of the disk and arm-plates microscopically granulated.

Description of a Specimen. — Diameter of disk 9 mm. Length of arm 25 mm. Width of arm 1 mm. The mouth papillæ, though closely soldered to each other, may be distinguished, in a partly dry specimen, by the light

* ὄφις, snake; μυσεῖον, mosaic.

lines between them; there are seventeen to each angle, of which the outer one is tooth-like and minute, and may be partially detached from the rest; the innermost, odd one is diamond-shaped, and lies immediately under the teeth; the others are squarish. Teeth four, flat, pointed, narrow; sometimes not placed regularly over each other. Mouth-shields small, of a truncated diamond shape, the truncation directed outward; length to breadth .8 : .6. Side mouth-shields broader without than within, where they meet, extending outwards beyond the mouth-shield, and joining the first side arm-plate; length 1.2 mm. Disk smooth above and below, and covered with a close mosaic of rounded scales, so intimately soldered that their outlines are indistinct. Radial shields blunt pear-seed shaped, widely separated by a group of small disk scales; length to breadth 1.8 : 1.2; they swell a little above the level of the others, and their surface, under the microscope, is composed of smooth grains, as is that of all the arm and disk plates. In the interbrachial space, between the pairs of radial shields, a single large scale occupies the margin of the disk. Under arm-plates three-sided and very small; the outer side is nearly straight, the laterals are re-enteringly curved and meet in a point within; length to breadth (5th joint) .5 : .4. Further out they rapidly become smaller, and, towards the tip of the arm, are scarcely to be seen. Side arm-plates very thick and swollen, meeting above and below, from the very innermost joint; at the fifth joint, their line of juncture is as long as the under arm-plate; and, further out, they constitute almost the whole of the joint. Upper arm-plates very small; longer than broad, diamond shape, with the outer angle shorter than the inner one; length to breadth (2d joint from disk) .8 : .6. Genital slits extending from the outer corner of the mouth-shield to a point about two thirds the distance to the margin of the disk; they are very narrow, and are bounded by two genital plates, which grow wider at their outer end, and are placed in a single line; moreover, there is a very narrow plate between the inner part of the slit and the side arm-plate. Arm-spines two, very short, scarcely tapering, cut square off at the end, nearly equal; lengths to that of the under arm-plate (5th joint) .3, .3 : 1. Near the tip of the arm the under spine is toothed, and hooked at the end, and the upper spine somewhat rough. There are tentacle-scales on the second and third joints, one to each pore; beyond this, neither tentacles nor scales; these scales are small, curved, and broader than long, and are situated close to the inner angle of the little under arm-plate, which gives them the look of being crowded towards the centre of the arm. The tentacles are short and small.

Color in alcohol, white.

Variations. — A young one had the disk 1.8 mm., the arm 6 mm. The scales of the upper disk were swollen and distinct, though closely soldered

together; in the centre a large rosette of primary plates, a large round one in the centre; a large, rounded pentagonal one in each brachial space; a small narrow one, wedged between these last, in each interbrachial space. Outside this rosette were the radial shields, touching each other; and, finally, there were two narrow plates, on a radiating line, in each interbrachial space between the pairs of radial shields, making thirty-one plates on the upper surface. Below there were only three plates in each interbrachial space, arranged side by side. The mouth-shields were broad, heart-shape; the side mouth-shields and mouth-papillæ nearly as in the adult. Of under arm-plates there were but two (including the one at the corner of the mouth-slit): of upper arm-plates, only one, on the first joint. There were tentacles on the second and third joints, just as in the adult, and none beyond. The place where upper and lower arm-plates will appear is indicated by a depression, just where the side arm-plates meet; and in this depression appears a little papilla, or lump, which at last takes on the form of a true plate. Thus, a larger specimen with a disk of 3 mm. and arm of 10 mm. had already nine upper and three lower arm-plates, but none beyond. Off Sand Key, 270 and 325 fathoms.

Ophiacantha meridionalis Lyman, sp. nov.

Ophiacantha pentacrinus? Lütken, Addit. ad. Hist. Ophiur. Pt. III, 1869, p. 46.

Special Marks. — Disk closely beset with minute stumps, each bearing a crown of fine thorns. Six long, very slender arm-spines. Arms five or six times as long as the diameter of the disk, rounded and slender.

Description of a Specimen. — Diameter of disk 4 mm. Length of arm 22 mm. Seven mouth-papillæ to each angle of the mouth; three on each side, which are short, bluntly tapering, stout, and separated from each other, and one situated immediately below the teeth, which it resembles in form. Teeth three, short, flat and wide, with a much curved cutting edge. Mouth-shields between a diamond and a heart shape, much broader than long, with the outer side nearly straight, except a projection at the middle point, and a rounded angle within; length to breadth .4 : .7. Side mouth-shields wide and strong, nearly straight, meeting within, and resting without, on the rudimentary first arm-plate, which is conspicuous and strong. Under arm-plates separated by the side plates along the whole arm, wider without than within; bounded without by a clean curve, on the sides by a slightly re-entering curve, and within by an obtuse angle; nowhere do they present a sharp corner, their outline being much rounded. Length (4th joint) .4 mm. Side arm-plates meeting above and below, their line of juncture being, at the base of the arm, quite as long as the lower arm-plate. Upper arm-plates small, not as wide as the arm, strongly curved without, and with an angle within, so that they form a sort of broad

diamond-shape. Disk completely covered, above and below, with very minute stumps, each of which bears a crown of microscopic thorns; on the back of the disc there are about 250 to a square mm. Radial shields entirely obscured, except just over the arms, where their outer ends are indicated by two little swellings. Arm-spines rounded, tapering, transparent, and very slender; under the microscope they appear finely prickly; on the basal joints six, of which the upper three are much the longest; lengths to that of the under arm-plate (4th joint) 1.5, 1.8, 1.8, 1.2, 1., .8 : .4. The two joints within the disk have but three spines, which are short, equal, flattened at their base, and quite rough. The end joints have three spines, also quite rough, and proportionately shorter and stouter than those of the basal joints, but there are no hooks, or toothed spines. Tentacle scales flat and sharp pointed, one to each pore. Color, in alcohol, pale blue gray for the disk, and white for the arms. The description given by Lütken of *O. pentacrinus* corresponds pretty nearly to this species. There is, however, one arm-spine less in *O. meridionalis*, and the under arm-plates appear to be of a different shape. Only a comparison of originals can determine the doubt.

In 237 and 327 fathoms.

Ophiomitra Lyman, gen. nov.*

Teeth: numerous, small, nearly equal mouth-papillæ; no tooth-papillæ. Disk flat, circular, and erect, covered with scales and radial shields, and beset with thorny spines, or stumps. Arm-spines rough. Side arm-plates large and nearly or quite meeting above and below.

So far as concerns the arms and the chewing apparatus, this is an *Ophiacantha;* but the disk, with its naked scales and conspicuous radial shields, separates it from that genus, which is characterized by the long, very narrow, radial shields, covered, together with the disk, by a thick skin bearing more or less thorny appendages.

Ophiomitra valida Lyman, sp. nov.

Special Marks. — Disk beset with thorny stumps; arm-spines about 9; the upper ones a little tapering, the lower ones flattened.

Description of a Specimen. — Diameter of disk 12 mm. Length of arm about 65 mm. Mouth-papillæ stout, rounded, tapering to a blunt point; from 10 to 11 to each angle of the mouth; of which one or two point directly inward. Teeth long, flat, tapering to a blunt point; 8 in number. Mouth-shields small, of a rounded diamond form, with a peak within; length to breadth 1.5 : 1.8. The madreporic shield has an ill-defined circular depression. Side mouth-shields large, meeting within, of a rude oval shape. They are quite as large as the mouth-shields proper. Under

* ὄφις, a snake; μίτρα, a cap.

arm-plates broader without than within, and broader than long; on 6th joint, length to breadth 1 : 1.3. The plates lying within the disk are much squeezed, laterally, by the large tentacles and their scales; beyond the disk they have a more regular shape, with the outer side strongly curved. Side arm-plates rather prominent, meeting above, but not below. Upper arm-plates wide fan-shape, with outer side strongly curved, and coming to a point within. Length to breadth 1 : 1.7. Disk, with a well-marked, round outline, standing off the bases of the arms; all its upper surface, except the radial shields, beset with little, rounded, thorny knobs or stumps, about .5 mm. high; they have a short, club form, like a folded toadstool, and bear a thorny crown; there are about eight of these stumps to a square mm., where they are thickest. Interbrachial spaces below have likewise a few of these stumps. The scaling of the disk, in a partly dried specimen, is easily seen. Radial shields of a blunt pear-seed shape, with a rather irregular and ill-defined outline; they are slightly separated, and are naked; length to breadth 2.2 : 1.5. Genital slits large and extending nearly to the margin of the disk. Arm-spines rough, and resembling those of the smoother species of *Ophiothrix;* the five upper ones slender, rounded, tapering gradually; the four lower ones somewhat flattened, scarcely tapering, blunt; lengths to that of the under arm-plate (6th joint) 3.8, 3.5, 2.5, 2.5, 2.2, 2.2, 2., 1.8, 1.8 : 1. Tentacle scales, two on the first pores; after that only one; those at base of arm are large, thin, longer than broad and cut square off at the tip; those farther out are much smaller and tend to become pointed. In alcohol, the specimens are of a uniform faded straw-color.

Variations. — A specimen with a disk of 9 mm. had only eight arm-spines next the disk, and seven a little farther out on the arm. The uppermost spine is sometimes shorter than the second, but the rest usually follow the proportions laid down. In large specimens the upper arm-plates have their outer curve very prominent.

This species has a rough resemblance to *Ophiothrix rosula:* and the genus has affinities with *Ophiothrix.* The lowest arm-spine, on the very tip joints, is a little curved and is strongly toothed on one edge, so as to form a partial hook.

Dredged off Sand Key, Florida, in 120 fathoms.

Ophiomitra sertata Lyman, sp. nov.

Special Marks. — Disk with small radial shields and beset with small spines and grains. Sixteen mouth-papillæ.

Description of a Specimen. — Diameter of disk 11 mm. Length of arm about 55 mm. Width of arm between the joints 2 mm. Mouth-papillæ about sixteen to each mouth-angle; two outer ones thin and nearly as wide

as long, with the end cut square off; the next five thin, narrow, sharp; the innermost one lies under the teeth, and, with its mate from the other side, forms a pair of papillæ much stouter than the rest and having a spear-head shape. Teeth five; the lowest one similar to the pair of mouth-papillæ just below it; the other four flat, rather stout, with a curved cutting edge. Mouth-shields broad heart-shape, with a slight peak without; length to breadth 1.2 : 1.5; just along their outer edge, in the interbrachial space, are five or six little spines. Side mouth-shields stout, broader without than within, running along the inner side of the mouth-shield and meeting within; they enclose the lateral corners of the mouth-shield by a little curved projection. Under arm-plates a little broader than long; bounded without by a clean curve, on the sides by slightly re-entering curves, and within by two curves which meet in a little peak on the median line. Side arm-plates stout, with a prominent ridge for the spines, meeting above and below, even at the first joint; they do not, however, encroach much more as they get farther out on the arm; and it is only near the tip that they occupy as much as half of its upper surface. Upper arm-plates broad-triangular, the outer side cleanly curved, and the lateral sides straight and meeting within in a sharp point; length to breadth (4th plate) .8 : 1. Disk above beset with rounded, rough grains, mingled with delicate, rounded spines, .8 mm. long, and shaped like those of the arm; through this covering appear the delicate disk scales; and, just over each arm, a pair of short radial shields, of a blunt pear-seed shape; these are smooth, but are separated from each other, and from the arm below, by bands of grains and spines; length to breadth 1.5 : 1. In the interbrachial spaces below, the spines and grains are less numerous. Genital slits large and occupying the full length of the interbrachial space; the edge next the interbrachial space is bounded by the five disk scales. Arm spines seven, all rough, slender, and regularly tapering; upper ones cylindrical, lower ones, especially the lowest, a little flattened; lengths to that of the under arm-plate (6th joint) 3.3, 2.5, 2.3, 2.2, 1.8, 1.5, 1 : .8. Tentacle scales large and regularly oval, length .5 mm. Color, in alcohol, disk blue gray, arm yellow gray. A single specimen, off Double-headed Shot Keys in 315 fathoms.

Ophiochondrus, gen. nov.*

Teeth and mouth-papillæ: no tooth-papillæ. Disk granulated; contracted, so that the interbrachial spaces are re-enteringly curved, and are further much reduced by the encroachment of the stout arms. Side mouth-shields wide and thick and meeting within. Side arm-plates meeting below, and there closely soldered so as to form a continuous belt. Two genital slits in each interbrachial space.

* ὄφις, snake; χόνδρος, granule.

Ophiochondrus convolutus Lyman, sp. nov.

Special Marks. — Six nearly equal, rounded, tapering arm-spines. Radial shields twice as long as wide and considerably separated. Seven mouth-papillæ. One tentacle scale.

Description of a Specimen. — Diameter of disk 7.5 mm. Length of arm 24 mm. Mouth-papillæ seven, all short, stout, and flattened; the two outer ones on each side squarish; the third more tapering, like a blunt tooth; the innermost one lying just under the teeth, and similar to them, except that it is more pointed. Teeth four, flat, squarish, with a cutting edge a little curved at its corners. Mouth-shields broader than long, rounded heart-shape; length to breadth .8 : 1.2. Side mouth-shields large and stout, meeting closely within: wider without, where they are soldered to the first side arm-plates. Under arm-plates wide oval, with a slightly re-entering curve without, strongly separated by the side arm-plates; length to breadth (6th joint) .5 : 1. Side arm-plates large, thick and swollen, not joined above, but meeting below, even at the base of the arm, where they are so soldered together that their line of juncture cannot be seen; their surface is rough, contrasting with that of upper and under plates, which is smooth. Upper arm-plates broad fan-shape, with the wide curved side outward; the two lateral sides are straight, and converge to the inner side, which is very short; the first upper plate is more or less covered by the encroachment of the disk; length to breadth (3d plate) 1 : 1.4. Three fourths out on the arm the upper plate is long wedge-shaped, with a curved outer side; this shape is determined by the juncture above of the side arm-plates. Interbrachial spaces below, and upper surface of disk, except radial shields, closely granulated with minute, rough, nearly equal grains, about 150 to a square mm. Radial shields widely separated; long oval, wider without than within; length to breadth, 2 : 1. The disk rises well above the arms, on which it encroaches somewhat by growing out on them in a sloping direction, as is often seen in *Ophiura*. Over the arm there is a slight irregular notch in the disk. Arm-spines short, rounded, tapering, moderately stout, nearly equal; second one from top a little the longest; lowest one somewhat the shortest. Second joint, two spines; third joint, three; sixth joint, six; lengths to that of the under arm-plate, .6, .7, .6, .6, .6, .5 : .5. At the very tip of the arm the under spine becomes somewhat hooked on its side and end. Tentacle scale, one, small, short, and tooth-like.

Color, in alcohol, light yellow.

Variations. — A small specimen brought up in the same cast is supposed to be the young of this species. Disk 2 mm. Arms 16 mm. The upper surface of the disk is entirely occupied by the eight radial shields, which are broad wedge-shape, and have the outer side bevelled, so as to make a

notch or re-entering angle in each interbrachial space. In the centre of the disk, and on the dividing lines between the shields, are a few rough grains or rather thorny stumps, of which each shield bears one or more near its outer end. Interbrachial space below wholly occupied by the very stout and swollen side mouth-shields, and the mouth-shield which closely fills the angle made by them. Under arm-plates bounded without by a curve, on the sides by re-entering curves, and within by an angle. Side mouth-shields stout and meeting above and below. Upper arm-plates fan-shape, with a curve without and a sharp angle within. Arm-spines (2d joint from disk) six; the three upper ones shaped as in the adult; the three lower much shorter and stouter, and suddenly swollen at the base; on the joints just beyond, five spines, which are short and stout. The chewing apparatus and other characters are nearly as in the specimen first described. It will be seen that, in character of arm-spines, armature of disk, and proportionate length of arm, this specimen differs much from its supposed adult; but I shall consider it as the young form, unless intermediate stages shall prove it a distinct species.

Both specimens from off Chozera, Cuba, in 270 fathoms.

This animal has a tendency to roll the tips of the arms upon themselves, which, with the contracted disk and the character of the arm-plates, give it the look of a young *Astrophyton*.

Ophiactis humilis Lyman.

Special Marks. — Disk covered with coarse scales, which are beset with short spines and short thorny clubs. Five spines, the two uppermost much the longest.

Description of a Specimen. — Diameter of disk 4 mm. Length of arm 11 mm. Seven long, rough, stout, spine-like tooth-papillæ .2 mm. long, standing well apart; the innermost one is broader and flattened, and very like the teeth, below which it stands. Three teeth, which are flat, longer than broad, with their cutting edge bluntly pointed. Mouth-shields broad heart-shape, broader than long, curved without, bounded within by two re-entering curves; length to breadth .3 : .5. Side mouth-shields large, extending outward as far as the outer corner of the mouth-shields; and loosely joined within, along a line equal nearly to the length of the mouth-shield itself. Under arm-plates broader without than within; bounded without by a slight curve, within by an obtuse angle, and on the sides by re-entering curves; length (3d plate) .3 mm. Side arm-plates large, meeting below along a line equal to more than half the length of the lower arm-plate; and above, equal to the whole length of an upper arm-plate. Upper arm-plates thick, but small, only about half as wide as the arm itself; heart-shaped, being curved without and pointed within. Disk covered with coarse, somewhat

irregular, overlapping scales, of which there are five or six in a line from the centre to the margin of the disk. These scales are beset with numerous bodies of two sorts; the first are short, stout, rough spines, similar in size and shape to the mouth-papillæ; the second are shorter but much thicker and have a thickened club form. In the interbrachial spaces below these spines are more scattered. Over each arm the outer points of the radial shields can just be seen; the rest is covered. Five rough, rounded, tapering, rather stout arm-spines; lengths to that of the under arm-plate (4th joint) 1.7, 1.5, .8, .7, .6 : .3. Towards the end of the arm there still are five spines, and the two upper ones much the longest. Tentacle scales, one to each pore; on the first two pairs of pores long, flat, and spine-like, resembling the mouth-papillæ; on the joints beyond, smaller and proportionately shorter.

Color, in alcohol, light brown.

Variations. — The two specimens from 125 fathoms had no spines on the disk, and only a few of the club-shaped grains.

In 125 and 321 fathoms.

This species, with *O. clavigera* Ljung., stands at one extremity of the genus and approaches *Ophiacantha* just as *O. Krebsii*, at the other extremity, tends towards *Amphiura*. The typical *Ophiactis* of Lütken is distinguished by great radial shields, flat arms, stumpy arm-spines, and feebly developed mouth-frames; its scaling is heavy, and the arm-plates are large and conspicuous; and, as such, it was set off from *Amphiura*. *Ophiacantha* is distinguished by the development of thorny appendages on the disk, which cover it closely; feeble upper and lower arm-plates; long, rough arm-spines; a stout chewing apparatus, which is somewhat like that of *Ophiocoma*, except the absence of tooth-papillæ; and very slender linear radial shields covered with skin.

O. clavigera is remarkable for its high arched disk.

Ophiactis plana Lyman, sp. nov.

Special Marks. — Disk scales smooth, without spines or grains. Four mouth-papillæ to each angle. Side mouth-shields touching the under arm-plate.

Description of a Specimen. — Diameter of disk 3.5 mm. Length of arm 10 mm. Mouth-papillæ,* two to each angle, situated at the outer corner

* It has been explained (see remarks on *Amphiura*) that this papilla is really the tentacle scale of the second pair of mouth tentacles. In describing *Ophiactis* there has been some confusion in this respect: thus, Mr. Ljungman says of *O. carnea*, "papillæ orales binæ" (four to each angle), "*altera* in summo sinu orali collocata": but this *second* one is the tentacle scale of the first pair of mouth-tentacles; and at that rate the species usually described as having four papillæ to each mouth-angle ought to be reckoned as having *six*, because these tentacle scales of the first pair are commonly overlooked.

of the slit; large, round, scale-like. Teeth four, flat, a little swelled, with a convex cutting edge, which in the lowest one (and to a less degree in those above) has a little lobe at its inner point. Mouth-shields small, swelled, broad heart-shape; length to breadth .2 : .3. Side mouth-shields small and narrow, not meeting within; soldered without to the inner lateral side of the second under arm-plate. Under arm-plates nearly pentagonal, with the angle directed inward, and truncated, making a very short sixth side; outer side curved; laterals re-enteringly curved; inner laterals straight; length to breadth (5th plate) .3 : .3. Side arm-plates stout, meeting above and nearly below. Upper arm-plates as wide as the arm, broader than long, bounded without by a clean curve, within by a very obtuse angle; length to breadth (3d plate) .3 : .4. Disk covered above and below with neatly imbricated scales, which are rather larger near the centre, where there are about 30 to a square mm. Radial shields slender pear-seed shape; a little bent so as to present a concave side to each other; separated for nearly or quite their length by a wedge of two or more elongated scales; length to breadth .8 : .4. No grains or spines on the disk scales, which are quite smooth. Arm-spines smooth, moderately stout, rounded, regularly tapering to a blunt point; nearly equal; lengths to that of the under arm-plate (5th joint) .5, .5, .5 : .3. One large, round tentacle scale, which resembles the mouth-papilla. Color, in alcohol, pale brown.

This species is distinguished from others by its lobed teeth and the entirely naked disk scales. It belongs to the group that have the side mouth-shields joining the under arm-plate. Off Carysfort Reef, 117 fathoms; off Key West, 140 fathoms; off Boca Grande, 125 fathoms; off Tortugas, 13 fathoms.

Ophiactis loricata Lyman, sp. nov.

Special Marks. — Side mouth-shields with their outer side touching the side arm-plate, and the first and second under arm-plates. Radial shields small. Upper and lower arm-plates long. Six arms.

Description of a Specimen. — Diameter of disk 2 mm. Length of arm 7 mm. Mouth-papillæ usually four to each mouth-angle, two on each side mouth-shield, of which the inner is very small and spine-like, but situated at the same level. Sometimes this second minute one is wanting, sometimes it is nearly as large as the outer. These variations may be looked for, because these creatures are peculiarly liable to mutilation, so that, of five specimens dredged, only one was perfect and symmetrical. Teeth, four; the upper one more sharp and narrow; the lowest sometimes divided into two papillæ. In the teeth, again, there seems some variation. Mouth-shields small, broad oval, rather swollen. Side mouth-shields stout, long triangular, nearly meeting within; the inner corner of the outer side fits in just where the first and second under arm-plates touch each other; the

outer side itself rests against the first side arm-plate. Under arm-plates longer than broad; touching each other; bounded within by a truncated angle, without by a curve, and on the sides by re-entering curves. Side arm-plates not meeting either above or below. Upper arm-plates much broader without than within; as long as, or longer than, broad; bounded without by a curve, on the sides by straight converging lines. Disk finely scaled below; above covered with irregular, rather coarse and swollen scales, some of which bear little, stout spines. Radial shields broad wedge-shape, small, their length not more than one fifth the diameter of the disk; touching each other only at their outer end; strongly diverging and separated by a wedge of two scales, placed end to end. Near base of arm, four short, stout, rough, nearly equal arm-spines; further out, three; one stout tentacle scale. Color, in alcohol, brown. In the covering of the disk, and especially the size and position of the radial shields, this species resembles the figures of *O. Ballii* and *O. abyssicola;** but the upper and lower arm-plates are quite different, and *O. Ballii* has five arm-spines; and the upper arm-spine of *O. abyssicola* is much the longest. *O. virens* has the side mouth-shields joined in a continuous ring.† There is a single specimen of a different species, dredged in 45 fathoms, which comes perhaps nearer to one of the above European species; but I propose to disregard it until I can have originals for careful comparison.‡

In 110 fathoms.

Amphiura semiermis Lyman, sp. nov.

Special Marks. — No scales on disk underneath. Six mouth-papillæ to each mouth-angle, of which two are above the others, in the mouth-slits. Side mouth-shields broad triangular and meeting within.

Description of a Specimen. — Diameter of disk 4 mm. The arms were broken, but their length seemed to have been about 30 mm. Mouth-papillæ six to each angle of mouth; a pair at the point of the angle, which are stout and rounded and run upwards to the teeth; one spiniform on the inner edge of the side mouth-shield; and one intermediate on each side, also spiniform, and situated high up in the mouth-slit. Teeth three, flat, strong, squarish, with a slightly curved cutting edge. Mouth-shields rounded oval, with a slight point within; length to breadth .5 : .4. Side mouth-shields broad triangular, large, meeting within; they extend nearly to the median line of the arm and overlap the first, rudi-

* Sars, Oversigt af Norges Echinodermer, Tab. II.

† Ljungman, Ophiuroidea Viventia, p. 323.

‡ In Catalogue No. 1, of Museum of Comp. Zoölogy, I have placed *O. abyssicola* under *Ophiocnida*, because I mistook the drawing given by Sars. I have not the same excuse for my blunder in putting *O. Ballii* there, for I had seen a specimen at Berlin.

mentary under arm-plate; under arm-plates nearly pentangular, but there is a very short inner side, because the inner laterals do not meet on the median line; they are bounded without by a slight curve; on the sides by curves a little re-entering; the inner laterals are also somewhat re-enteringly curved: length to breadth (5th plate) .5 : .4. Side arm-plates quite large, and encroaching both above and below; nearly meeting above. Upper arm-plates rounded, with a peak within; they do not cover the whole upper surface, but on each side appear the side arm-plates; length to breadth (3d plate from disc) .5 : .5. Disk finely scaled above, naked below; scales rather larger towards middle of disk; near its edge there are about 140 to a square mm., all thin, and overlapping. Radial shields narrow, broader without than within; their sides overlapped by the disk scales; nearly, or quite, touching without; diverging a little within; separated near their outer ends by a single long scale, and, further inward, by a bunch of the imbricated disk scales, length to breadth 1 : .3; they vary somewhat, accordingly as they are more or less encroached on by the disk scales. Just outside and below each of them is a small radial scale. Arm-spines, near base of arm, five; further out, four; stout, rounded, tapering to a point, swelled at the base; the two upper ones slightly longer and more slender; lengths to that of under arm-plate (5th joint) .5, .5, .4, .4, .4 : .5. Tentacle scales two, small, broader than long, curved; placed at right angles to each other, one on the lateral side of the under arm-plate, the other on the outer edge of the side arm-plate.

Color, in alcohol, disk greenish gray, arms yellowish.

A single specimen, from 377 fathoms, south of Rebecca Channel.

The specimen was somewhat injured, and therefore I wait better examples before separating the species from *Amphiura*, from which it differs by its naked disk underneath, just as does *Hemipholis*. Otherwise, it belongs to the *Amphiura* group, in which are found the well-known European *A. Chiajii* and the Florida *A. Stimpsonii*. This group is commonly described as having one *mouth-papilla* at the outer corner of the mouth-slit, and *another* high up in the mouth-slit itself. As the term mouth-papilla is understood, this description is not true. The papilla at the outer corner of the mouth-slit is the *tentacle scale* of the second pair of mouth-tentacles; that within the mouth-slit is the tentacle scale of the first pair of mouth-tentacles. The scale of the second pair of tentacles may easily be found in such genera as *Ophiocoma*, but naturalists do not there speak of it, because it is hidden by the continuous row of true mouth-papillæ. The group, therefore, should not be spoken of as having six mouth-papillæ, but as having *two* mouth-papillæ at the apex of the angle, and one large scale to each of the mouth-tentacles. Its species are, moreover, characterized by the number of the arm-spines, which are rarely less than five and occa-

sionally as many as eight, while the other group has three or four. When we can be sure of the full value of the characters these two divisions will doubtless appear as generically distinct.

Amphiura grandisquama Lyman, sp. nov.

Special Marks. — Five arm-spines, the lowest much the longest, and a little bent. One rounded tentacle scale, larger than is usual in the genus. Six mouth-papillæ to each mouth-angle, of which two are above the others in the mouth-slits.

Description of a Specimen. — Diameter of disk 6 mm. The arms, which were broken, had been not far from 28 mm. long. Of the six mouth-papillæ, to each mouth-angle, the innermost are stout and rounded, and stand side by side at the apex of the angle, running upwards to the teeth; the outer ones are very stout and taper to a blunt point, and one stands on the inner edge of each side mouth-shield; the intermediate ones are smaller and sharp spiniform, and are high up in the mouth-slit. Teeth flat, rather stout, with a cutting edge, a little curved. Mouth-shields broad, rounded diamond shape, more obtuse without than within; length to breadth .5 : .4. Side mouth-shields long triangular, small, not meeting within. Under arm-plates broader without than within; bounded without by a curve; on the sides by re-entering curves, which incline toward the median line; the inner laterals are short and nearly meet on the median line, so that the inner side is very small; length to breadth (6th plate) .5 : .5. Side arm-plates encroaching somewhat both above and below. Upper arm-plates extending quite across the arm, broader than long; they have a clean curve without, and a broken curve within, and these meet, on either side, in an obtuse point; length to breadth (3d plate from disk) .5 : .6. Disk covered with fine, overlapping scales, above and below, which are coarsest near the centre of the disk, and finest underneath; near the edge, above, there are about 100 to a square mm. Radial shields narrow; wider within than without, their side turned toward the other nearly straight; the opposite side curved; they are separated by a narrow wedge of two or three long scales; length to breadth 1 : .1: their size varies with the encroachment of the disk scales. Arm-spines five; further out on arm, four; rounded, tapering regularly, little or not at all swelled at the base; lowest one longest, and generally a little bent; lengths to that of the under arm-plate (7th joint) .6, .7, .7, .7, 1 : .5. Tentacle scale large, and round oval, resembling that in *Ophionereis;* length to that of the under arm-plate .2 : .5. Color, in alcohol, pale brown, with a light spot at the outer end of each radial shield.

Off Tennessee Reef, in 174 fathoms.

The species belongs to the same group as its neighbor, *A. Stimpsonii,* but

is readily distinguished by its larger tentacle scales, and longer, more tapering arm-spines. *A. Sunderalli* is also similar, but has the side mouth-shields meeting within, and very broad, and the arm-spines more stumpy. *A. Stimpsonii*, hitherto only known by Lütken's description (Addit. ad Hist. Ophiur., Part II, p. 116) has the proportions of the disk and arms much as in *A. grandisquama*. The mouth-shields are longer than broad; the side mouth-shields small and narrow, meeting within, closely soldered to the surrounding parts, and, at their outer end, to a very small rudimentary under arm-plate; at base of arm, one very small tentacle scale; further out, none at all; radial shields closely joined at their outer ends; within, separated by a couple of long scales: five short, stumpy arm-spines.

Remarks on the Groups in the Genus Amphiura. — Any one who is really familiar with the range of species in this genus will, on the one hand, recognize striking differences, while, on the other, he will find a real difficulty in dividing the groups in a way to bear criticism. Lütken very properly set off the genus *Ophiactis:* and I have since separated the *Amphiuræ* with spiny disks under the name *Ophiocnida*, and those with a fence of scales round the discs as *Ophiophragmus*. Professor Agassiz had already recognized the generic position of the species with a naked disk below, under the name of *Hemipholis*. Mr. Ljungman * further distinguishes a genus *Amphipholis*, of which the type is *A. Januarii*, which seems to belong with such species as *A. elegans* (*Amphiura squamata* Ltk.) and *A. tenera*. It is by no means clear on what characters Mr. Ljungman grounds this new genus; because, after giving a number of characters common to nearly the whole of the old genus, he concludes with this distinction: "A generibus *Hemipholide* et *Amphiura* numero et dispositione papillarum oralium differt." But the species which he includes under *Amphipholis* do not at all agree *among themselves* in the number or disposition of their mouth-papillæ; e. g. *A. tenera*, *A. occidentalis*, and *A. atra*. There certainly is a group which includes *Amphiura elegans* (*squamata*), *A. tenera*, *A. violacea*, and *A. pugetana*, whereof the members are not only closely allied generically, but are even difficult to distinguish *specifically*, though coming from faunæ the most widely separated. Thus, Mr. Ljungman gives *A. elegans* as coming from the shores of Northwestern Europe, and also the Cape of Good Hope (!). And since this species has been shown to vary so considerably in its arm-spines, it seems difficult to separate it any longer from *A. tenera* of the West Indies; and, further, from *A. violacea*, *A. microdiscus*, and *A. Puntarenæ* of the Pacific coast of America. Should all, or a part, of these species prove identical, we must look upon this animal as the common thread that binds together distant faunæ, just as characteristic

* Ljungman, Öfversigt af Kongl. Vet. Akad. Förhand., 1866, p. 165.

fossils determine stratified rocks in different parts of the world. This idea of community of existence gets some strength from the varying depths at which *A. tenera* is found (4 to 128 fathoms), while its northern representative, *A. squamata* or *elegans*, is found from the Mediterranean, on the east, to Cape Cod, on the west; and from low water to three hundred fathoms* (var. *tenuispina*). The new genus *Amphilepis* Ljung.† seems better grounded. It contains the new species *A. norvegica*, and is characterized by only four mouth-papillæ to each angle and by absence of tentacle scales. However this may be, there are groups in *Amphiura* quite as clearly marked generically as is *Amphilepis*, and especially that already referred to as including *A. grandisquama*, which is characterized by having only two mouth-papillæ placed just under the teeth, a deficiency made up by the development of the tentacle scales of the two pairs of mouth-tentacles; furthermore, the many-spined *Amphiuræ* (4 to 8) are all found in this group. Its species, eighteen in all, are embraced in the table on pp. 338 and 339.

I by no means wish to suggest, because so many minor differences are thus indicated, that an equal number of generic differences should be recognized; on the contrary, no naturalist has a right to take such a step, unless he has had most of the species *under his own eye* for critical comparison.

Next to *A. planispina* stands the genus *Hemipholis*, which has two species, — *H. cordifera* Lym. and *H. affinis* Ljn.‡ *Ophiocnida* and

* Sars, Over det dyriske Livs Udbredning i Havets dybder, 1868.

† Ljungman, Ophiuroidea Viventia, p. 322.

‡ Its synonyme is *H. gracilis*, Vll. Professor Verrill (Proceed. Boston Soc. Nat. Hist. XII, 391) thinks that he has priority in the name, because, in a separate publication of Ljungman's Ophiuroidea Viventia, there is a note by Lovèn dated May 18, 1867. But this note has nothing to do with the original publication which is in the Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1866, No. 9. Ljungman's paper was read November 14, 1866. Verrill's was read January, 1867, and published in Trans. Connecticut Academy, March, 1867. This whole matter of priority in descriptions is of no sort of interest to science, except as a matter of *registration*. Nor is it profitable to enter on the question of what constitutes *publication*. But we may say, that the partial distribution of loose sheets of an incomplete paper, though a useful and praiseworthy custom, constitutes no greater claim for *priority* than the reading of a paper before an ancient and distinguished Academy, and the speedy publication of that paper in its complete and connected form. There are now many zoölogists who seem to think that species must be continually "reported," just like stocks at the brokers' board. Agassiz showed, twenty-three years ago, in his preface to the Nomenclator Zoologicus, that the "authorities" placed after names were merely *references of registration*, and not marks of praise to the authors. Thus when we read *Ophioderma longicauda* Müll. and Trosch., it means not, "The illustrious zoölogists Johannes Müller and F. H. Troschel had the honor to give the above (wrong!) name to this species"; *but*, "If you look in the System der Asteriden, you will find what Müller and Troschel thought or knew of this species."

Ophiophragmus are distinguished, not by the chewing apparatus, but by the covering of the disk. The former has four species, — *O. hispida* Lym., *O. brachiata* Lym., *O. scabriuscula* Lym., *O. olivacea* Lym.* The latter has five species, — *O. septus* Lym., *O. Wurdemani* Lym., *O. marginatus* Lym., *O. antarcticus* Ljn., *O. gibbosus* Ljn.

Finally, to complete that part of Müller and Troschel's genus Ophiolepis, which centres in *Amphiura*, we must mention *Ophiostigma* and *Ophiactis*. The latter approaches *Amphiura* in one direction (*O. Krebsii*), *Ophiopholis* in another (*O. Kröyeri*), and *Ophiacantha* in a third (*O. clavigera*). See description of *Ophiactis humilis*.

Amphiura pulchella Lyman, sp. nov.

Special Marks. — Six mouth-papillæ to each angle, the inner pair thick and running upward to the teeth. Radial shields very narrow, and closely joined for nearly their whole length.

Description of a Specimen. — Diameter of disc 3.2 mm. The arm was broken off at 21 mm., but had apparently been about 28 mm. long. Mouth-papillæ three on each side, all on the mouth-frames; the two outer ones small, rounded, and scale-like; the innermost one thickened and running upwards to the teeth. Mouth-shields longer than broad, rather narrower within than without. Side mouth-shields very narrow within, where they meet; much broader without, where they touch the minute first under arm-plate with their corner. Under arm-plates separated; as broad as long, pentagonal with the angle inward; lateral sides re-enteringly curved; outer side nearly straight on the first three or four plates; beyond that, with a decided notch in the outer side. Side arm-plates meeting below and (after the second joint) above also; the separation, however, of the upper and under plates is narrow; length of third plate .2 mm. Upper arm-plates broader than long, of an oval form, with the inner curve greater than the outer. Beyond the second joint they are slightly separated. Disk closely covered with minute imbricated scales, of which there are about 100 to a square mm., where they are smallest, on the upper surface. In the centre is a distinct circle of five round primary plates, with a sixth in the middle. Radial shields narrow, and sunk in the disk, joined for their entire length closely, except just at their inner extremities; length to breadth .9 : .2. Arm-spines three; short, smooth, rounded, tapering, nearly equal; lengths to that of under arm-plate .3, .3, .3 : .2. One small, nearly circular tentacle scale.

Color, in alcohol, disk greenish gray, arms lighter.

In 39 fathoms.

* To these should apparently be added *Ophiophragmus Loveni* Ljn. and *O. echinatus* Ljn. Why he placed them thus, and still admitted the genus *Ophiocnida*, is not clear.

Amphiurae with only a pair of mouth-papillae just under the teeth; the tentacle scales of the two pairs of mouth-tentacles strongly developed; 4-8 arm-spines.

Two tentacle scales.	4 arm-spines; often an additional mouth-papilla	A. Eugeniæ Ljn. Near R. La Plata.
	5–6 arm-spines; under arm-plates pentagonal	A. Chiajii Fbs. W. Europe.
	5–7 arm-spines; under arm-plates pentagonal	A. complanata Ljn. Off Rio de Janeiro.
	7 divaricate arm-spines	A. divaricata Ljn. Near Batavia.
	7 rather long arm-spines; side mouth-shields separated	A. flexuosa Ljn. Brazil.
	8 sharp arm-spines; disk large (11 mm.)	A. crassipes Ljn. Off Rio de Janeiro.
	Outer mouth-papilla scale-like	A. candida Ljn. Mozambique.
	5 arm-spines; long arms; (probably belongs here?)	A. perplexa Lym. Sidney.
	Side mouth-shields wide triangular; no scales below	A. semiermis Lym. Florida.
	Two tentacle scales at base of arm; none beyond	A. verticillata Ljn. Gallapagos.
One tentacle scale.	Minute tentacle scales	A. Stimpsonii Ltk. Florida.
	Side mouth-shields wide triangular	A. Sundevalli Ljn. W. Europe.
	Tentacle scales large, rounded oval	A. grandisquama Lym. Florida.
	7 rough arm-spines; lowest longest	A. magellanica Ljn. Str. Magellan.
	6 or 7 wide arm-spines	A. capensis Ljn. C. Good Hope.
No tentacle scale.	5–7 arm-spines	A. latispina Ljn. Off R. La Platta.
	6 arm-spines; arms very long	A. atlantica Ljn. St. Helena.
	Very long arms; 5–7 arm-spines	A. filiformis Fbs. W. Europe.

It is for this group that *Amphiura* must be retained, if the genus is to be subdivided. (See Forbes in Trans. Linn. Soc., Vol. XIX, p. 150.)

The rest of the genus embraces	A. elegans Norm. W. Europe and N. E. America.*
	A. pugetana Lym. Puget Sound.
	A. tenera Ltk. W. Indies.
Two tentacle scales. Mouth-shield small, and wedged between two wide, thick, side mouth-shields, which meet within. Outer mouth-papilla much wider than the rest. The whole mouth apparatus with its shields forms a conspicuous raised pentagon. These species form part of *Amphipholis* Ljn., and are noted for their close resemblance	A. depressa Ljn. Near Batavia.
	A. violacea Ltk. W. coast of tropical America.
	A. microdiscus Ltk. " " "
	A. puntarenæ Ltk. " " "
	A. Örstedii Ltk. " " "
	A. integra Ljn. Port Natal, S. Af.
	A. hastata Ljn. Mozambique.
	A. Januarii Ljn. Rio de Janeiro.†
Mouth-papillæ equal. Radial shields, short and stout and closely joined	A. grisea Ljn. W. Cent. America.
	A. Riisei Ltk. W. Indies.
7 or 8 short, wide (except the innermost) mouth-papillæ, under arm-plates wider within than without	A. atra Ltk. S. Carolina.
Six mouth-papillæ to each angle: radial shields very narrow and joined closely	A. pulchella Lym. Florida.
Mouth-papillæ equal. Side mouth-shields small and not meeting within	A. chilensis Ltk. Chili.
	A. occidentalis Lym. N. W. America.
	A. urtica Lym. N. W. America.
Outer mouth-papilla widest. Side mouth-shields small and not meeting within	A. geminata Ltk. W. Cent. America.
	A. gracillima Ltk. S. Carolina.
Four mouth-papillæ to each mouth-angle. No tentacle scales (*Amphilepis* Ljn.)	A. norvegica Ljn. Norway.
Two mouth-papillæ to each mouth-angle	A. planispina Pet. Rio de Janeiro.
Eight mouth-papillæ; two tentacle scales	A. impressa Ljn. Near Batavia.
Six arm-spines, two tentacle scales	A. lobata Ljn. Sidney, N. H.
Six unequal mouth-papillæ to each angle. Radial shields separated	A. limbata Ltk. Rio de Janeiro.

* Norman. Ann. and Mag. of Nat. Hist., 1865, p. 109.

† Mr. Ljungman informs me that *A. albida* and *A. subtilis*, Ljn., are probably identical with *A. Januarii*.

Despite the number of *Amphiuræ* described from the Gulf of Mexico and waters of Brazil, the species seem well defined and distinct; and there is promise of many more. This genus is remarkable fort he well-defined specific differences it presents in the character and position of its side mouth-shields, arm-plates, mouth-papillæ, radial shields, &c. For example, no other *Amphiura* presents the following combination found in *A. pulchella:* 1. Three mouth-papillæ on a side, the innermost thickened. 2. Slender radial shields, closely joined. 3. Upper and lower arm-plates separated. 4. Three arm-spines. 5. One tentacle scale.

Ophiocnida olivacea Lyman, sp. nov.

Special Marks. — Radical shields deeply sunk in the disk, long and narrow. Disk puffy, with a narrow notch over each arm. At the base of the arm two tentacle scales, of which one is small and stands on the side arm-plate, the other long spiniform and borne on the lateral side of the under arm-plate.

Description of a Specimen. — Diameter of disk 12 mm. Length of arm about 85 mm. Mouth-papillæ, twelve to each angle, arranged in three sets: first, two small, flat, tooth-like papillæ, one at each outer corner of the mouth-slit, standing well above the outer end of the side mouth-shield (these, of course, are the tentacle scales of the mouth-tentacles); secondly, four sharp, stout, rounded, tapering papillæ on each side, standing in a row, which runs from the middle point of the side mouth-shield, upwards and inwards, along the mouth-frames to a level with the second tooth; of these the outer one is largest, .7 mm. long; thirdly, two stout, conical papillæ standing on the point of the mouth-frames, and directed inward, but inclined from each other, so that they have the appearance of a blunt fork. Teeth six, of which the lowest is pointed somewhat like the mouth-papillæ next to it; the other five are flat, squarish, with a curved cutting edge. Mouth-shields small, of a broad, rounded heart-shape; length to breadth 1.4 : .7. Side mouth-shields narrow and small, pointed within (where they nearly meet), broader without, where they run to the lateral corner of the mouth-shield. Under arm-plates longer than broad, bounded within by a nearly straight line, on the sides by re-entering curves, and without by two little re-entering curves, which join in a small peak on the median line; length to breadth (10th joint) .8 : .6. Inside the disk these plates are especially encroached on by the tentacles, which are very large, and occupy much of the under surface of the arm. Side arm-plates moderately prominent, and conspicuous from below by reason of the narrow under arm-plates; they do not, however, meet, except at the very tip of the arm, where they come together above. Upper arm-plates broader than long, a little broader without than within; all their sides nearly straight; the outer one lightly curved; length

to breadth (3d joint from disk) .8 : 1.1. Towards the tip of the arm they are triangular, with the outer side curved, and the apex directed inward. Disk covered with fine scales and radial shields; the former nearly hidden by the skin, except on the lower surface. Radial shields very narrow, and joined for their whole length; pointed within, swollen at their outer ends; length to breadth 2 : .5. They are sunk below the puffy surface of the disk, and are placed at the inner point of a notch in the disk, which exists over each arm; this inlacing of the soft disk is as deep as one or two arm-plates, portions of which are thus exposed, together with their spines, which are bent outward by the overlying disc margin. The sides of the notch are formed of an upward prolongation of the genital plate. The entire disk is pretty evenly beset with very slender, sharp spines about .6 mm. long. Genital slits with a distinct genital plate, whose edge is visible for its whole length, and which turns over and widens at each end, especially at the outer, where it runs upwards above the arm. Arm-spines, outside the disk and near base of arm, nine, whereof the two lowest are stout, rounded, pointed, and longer than the others; the next four flattened, tapering, and most slender; the three highest also flattened and tapering, but rather stouter; lengths to that of under arm-plate (10th joint) 1.1, 1.1, .9, .7, .7, .7, .7, .7, .7 : .8. On the second joint only two spines; on the other joints, within the disk, about three. Near tip of arm, four spines, lowest longest, slender, tapering, rounded, rather longer than the joint. Tentacle scales two, — one short, sharp, tooth-like and about .4 mm. long (10th joint), standing on the edge of the side arm-plate; the other slender, sharp, spiniform, and borne on the lateral edge of the under arm-plate; length (10th joint) .6 mm. The former of these scales is found to the very tip, where it takes on the form of a pointed oval; but the spiniform scale is only seen on the first third of the arm, where it disappears, having grown gradually shorter and smaller.

Color, in alcohol, dull olive for the disk; arms, light olive brown.

Three specimens, in 79 fathoms, off Alligator Reef; and two arms, in 40 and in 117 fathoms, off Carysfort Reef.

Ophiothamnus Lyman, gen. nov.*

Teeth: no tooth-papillæ: mouth-papillæ, of which the outer is much the broadest. Side mouth-shields long and stout, extending outside the mouth-shields, and making, with them, a conspicuous raised pentagon. Side arm-plates large, meeting above and below, and bearing slender, rough spines on their sides. Disk puffed, and overlying the bases of the arms, covered with scales and radial shields, which are beset with spines.

This genus, by its arm-plates and chewing apparatus, is allied to

* ὄφις, a snake; θάμνος, a thicket.

Amphiura; by its spinous disk and rough spines, to *Ophiacantha* and *Ophiomitra.*

Ophiothamnus vicarius* Lyman, sp. nov.

Special Marks. — Disk beset with numerous slender spines. Seven or eight arm-spines; the upper ones longest, and all slender and tapering. Seven mouth-papillæ.

Description of a Specimen. — Diameter of disk 3.5 mm. Length of arm 20 mm. Mouth-papillæ, seven to each angle, whereof the innermost one stands immediately below the teeth, and is just like them; of the three papillæ on each side, the two inner ones are together about as broad as the outer one. The seven make an even, crowded row, and are all stout. Teeth four, short, broad, flat, with the cutting edge slightly curved, the uppermost one thinnest. Mouth-shields small, .3 mm. long, pointed within, a little curved without, making a sort of heart-shape; they are closely wedged into the angle formed by the union of the side mouth-shields. Side mouth-shields large and strong, .5 mm. long, meeting within, and extending well outside the mouth-shield proper; they bear the outer wide mouth-papillæ, while the other mouth-papillæ are attached to the mouth-frames, except the central innermost one, which grows on the jaw itself. Under arm-plates wider without than within; outer side curved slightly, laterals encroached upon by the tentacle scales; inner side making a small peak or angle; length (4th joint), .3 mm. The first under arm-plate is oblong, and tightly pressed between the bases of the side mouth-shields. Side arm-plates large, and rather prominent, meeting above and below; their line of juncture below is about half as long as the under arm-plate. Upper arm-plates, .3 mm. long: outer side cleanly curved, and nearly as wide as the arm: within they are bounded by outer curves of the preceding side arm-plates, which give them the appearance of having a peak. Disk beset, above and below, with long slender spines, which are more numerous on the upper surface, where their length is .5 mm., while, in the lower interbrachial spaces, the longest are .3 mm. In a dry specimen, the somewhat coarse and irregular scaling of the disk is everywhere visible. Radial shields, roughly semicircular, so that together they make a round figure; their outline, however, is not regular, and they have a slight swelling at their outer point; they touch each other near the disk margin; but, within, are separated by one, and sometimes by two, large scales, on their edges they often have two or three spines. Arm-spines slender, rounded, gradually tapering, sharp, all similar in shape, upper ones longest; close to the disk they are much longer than just beyond; fourth joint, eight spines, whose lengths are, to that

* So called because it seems to replace the common *Ophiothrix* of the shallower water.

of the lower arm-plate, as 1.1, 1.1, 1.3, .9, .7, .6, .6, .5 : .3. Seventh joint, longest spines, .5 mm., and the rest are not much shorter. On the first two or three joints beyond the disk the two ranges of spines meet on the median line of the arm above. The second arm-joint has but three spines, and of these the lowest is, as an exception, longest, namely, .6 mm. Tentacle scales blunt, pear-seed shape, the apex outward, further out on the arm they grow more pointed; their length is about half that of the under arm-plate. The color, in alcohol, is pale brown for the disk, and light straw for the arms.

Variations. — The chewing apparatus shows few exceptions: sometimes, however, the central inner mouth-papilla is somewhat narrower than the teeth above it: very rarely one of the small, side mouth-papillæ is wanting. The number and lengths of the disk spines is not always the same; and especially are those near the margin sometimes shorter. In the larger specimens the second joint has four spines.

Among numerous specimens there was found one that had scarcely any spines on the disk, and those very short; while the radial shields were buried by the disk scales, except their outer ends. The arm-spines were essentially the same; on the fifth joint, lengths to that of the under arm-plate, 1., 1., .8, .8, .8, .6, .6, .5. : .3.

Numerous specimens, in 15 to 135 fathoms.

Ophiomyces Lyman, gen. nov.*

Teeth: no tooth-papillæ; numerous wide, flat mouth-papillæ, which are turned downwards and outwards, and arranged in two or more imbricated rows, covering the whole mouth-angle. Side mouth-shields large, and meeting above. Disk finely scaled, without visible radial shields. Arm-spines within the disk shorter, stouter, and of a different character from those of the joints further out.

This singular genus stands quite by itself, unless we compare its curious mouth-papillæ with the spatula-like tentacle scales of *Ophiopsila*. All the specimens I have seen had a tendency to raise the arms above the disk, vertically; which shows that the muscular tension must have some peculiar proportion.

Ophiomyces mirabilis Lyman.

Special Marks. — Six arm-spines, nearly equal; on the second joint a connected row of ten short, flat arm-spines, running across the under side of the arm, two of these spines being on the under arm-plate, and four on each side arm-plate.

Diameter of disk about 6 mm. Length of arm 17 mm. The inner mouth-papillæ are rounded, sharp, spiniform, and eight or ten in number;

* ὄφις, a snake; μύκης, a mushroom.

they form an irregular row about the inner mouth-angle, and usually are turned more or less downwards. The outer mouth-papillæ are all more or less widened and flattened; arranged rudely in four radiating rows, but so spreading and overlapping as to almost hide the whole outer part of the mouth-angle. There are five or six to each side (ten or twelve to each mouth-angle) all foliate in form (much like the woolly fungus that grows from dead trees) the outer ones largest, and sometimes 1 mm. wide. Teeth five, flat, sharp, spear-head shaped. Mouth-shields very small, diamond shape, and almost totally hidden by the mass of papillæ and spines about them. Side mouth-shields large, meeting within, with a vacant space between their enclosed angle and the mouth-shield proper. They carry all the characteristic foliate mouth-papillæ, and are very much larger than the mouth-shield. The lower and inner point of the jaw, which in most Ophiurans is scarcely to be seen, is here quite large, and carries all, or nearly all, the spine-like mouth-papillæ. Under arm-plates much wider without than within; outer side curved, with a lateral projection from each corner, which joins the side arm-plate; laterals strongly re-enteringly curved, by the encroachment of the tentacle pores, which are very large; inner side making a sharp angle; length of plate (6th) to greatest breadth .5 : .5. Side arm-plates meeting above and below; above they cover almost the whole surface, the upper arm-plate being reduced to a minimum. Upper arm-plates with a curved outer side; the inner side with a rounded angle; they occupy only a small spot of about half the width of the arm, between the bases of the arm-spines. Disk uniformly covered with very fine, thin scales, about fifty to a square mm. Scattered over the upper surface are a very few short, delicate spines; in the lower interbrachial spaces, just outside the mouth-shield, a group of little flat papillæ. Arm-spines on joints beyond the disk six; the three upper ones slender, rounded, tapering; the three lower a little flattened and more blunt; upper spines longer; the longest (6th joint) .7 mm. Within the disk the spines have an entirely different form. Second joint with an unbroken row of ten equal, short, flat, scale-like papillæ, whereof two are on the under arm-plate, and four on each side arm-plate. Third and fourth joints the same, except that the papillæ get more rounded and longer, and that the fourth joint has only three on each side arm-plate. Tentacle scales of second joint two; of a shape similar to the outer mouth-papillæ, and lying on the side of the pore opposite the under arm-plate. All succeeding joints have but one scale, which lies on the inner angle of the under arm-plate. The two scale-like spines on the under arm-plate disappear beyond the sixth joint; they may, indeed, be considered *tentacle scales* just as properly as *arm-spines*. Some species of *Ophioglypha* give similar instances. The tentacle scales, except those of the second joint, are flat, oblong, and similar to the

arm-spines which lie within the disk; far out on the arm they grow somewhat pointed.

Color, in alcohol, uniform pale gray.

The chief variations noticed were in the shape of the singular outer mouth-papillæ, which are sometimes more spreading in their form, or narrower. The number of these, as well as of the inner mouth-papillæ, varies by one or two, for each angle of the mouth.

Off Sand Key, Florida, in 237 to 306 fathoms.

The specimens, many of which had cast their disks, were singularly distorted, probably by the change of pressure from so considerable a depth. The arms were twisted upwards, so that they made a parallel bunch, in the midst of which was the disc, much elongated. By this torsion the mouth parts were all turned outwards, and almost inverted. This singular twisting is unusual.

The species may readily be distinguished from *O. frutectosus* by the fewer spines and their comparative equality.

Ophiomyces frutectosus Lyman.

Special Marks. — Twelve arm-spines, of which the uppermost is close to the median line of the arm. The five upper ones are short and sharp; the next three long, tapering, slender; the last four shorter, flattened, and equal.

Description of a Specimen. — Diameter of disk 7 mm. Length of arm about 28 mm. The inner mouth-papillæ are rounded, stout, spiniform, seven or eight in number; they form an irregular row about the inner mouth-angle, and are often turned more or less downward. The outer mouth-papillæ are flattened and broad; wider at their ends, which are cut square off, than at their bases; rudely arranged in four radiating rows, but inclining downwards and outwards, and so overlapping as to cover the outer part of the mouth-angle, like tiles; there are fourteen or sixteen to each mouth-angle; the longest are .7 mm., and are outside. Teeth four (rarely five), short, flat, stout, with a curved, cutting edge. Mouth-shields very small, diamond-shaped, and almost hidden by the numerous spines and papillæ about them. Side mouth-shields completely hidden by the outer mouth-papillæ. Under arm-plates nearly as wide within as without; their lateral sides with a strong re-entering curve from the encroachment of the large tentacle pores; length to breadth (6th) .6 : .5. Side arm-plates meeting above, but not below; near the base of the arm they barely meet above. Upper arm-plates very thin and delicate, except a median, thickened crest; their outer side strongly curved, their inner side with a slight peak; they occupy only about half the width of the arm; length to breadth .5 : 1.2. Disk covered with fine, slightly thickened scales; about

70 to a square mm. In the centre of the disk they are somewhat larger; and, in the interbrachial spaces below, much more minute; everywhere they are closely imbricated and somewhat irregular in size. The entire disk, above and below, is beset with a considerable number of very fine, sharp, slender spines; the longest about .8 mm.; just outside the mouth shields is a patch of stouter and blunter spines. Arm-spines, on the joints just outside the disc, twelve, arranged from the median line of the arm above to the tentacle pore below. The uppermost spines are very short and sharp, and project over the succeeding upper arm-plate. The sixth, seventh, and eighth spines long, slender and tapering; the four lowest spines not so long, but stouter, blunt, flattened, and smallest at the base. Lengths to that of the under arm-plate (6th joint) 3., .3, .4, .4, .5, 1., 1., .8, .6, .6, .6, 6, : .6. On the joints within the disk, the lower spines are wider, blunter and more flattened; while the upper ones are slender, but not so long as those on the joints beyond the edge of the disk. Third joint with twelve spines; the six lower ones are arranged on the side arm-plate, nearly at right angles with the length of the arm, but here the side arm-plate makes a sudden bend outwards and upwards, and this part bears six slender, sharp spines, of which the upper ones are somewhat the shortest; all these last are difficult of detection, wedged, as they are between the arm and the lower side of the disk. Tentacle scales two to each pore. On the first five or six joints the scales are shaped just like the peculiar outer mouth-papillæ, and are attached to the under arm-plate near the curved margin of the pore. On the joints beyond, the inner scale is pointed oval in shape, and attached to the side arm-plate next the lowest spine, while the outer scale is more elongated and is attached to the under arm-plate.* Close to the end of the arm the inner scale only remains, and gets somewhat more pointed. In alcohol, grayish straw color.

A single specimen off Sand Key, Florida, in 100 fathoms; others in 77 and 160 fathoms.

This species, when examined with a lens, presents a confused mass of thousands of spines and papillæ of all shapes and sizes; and it is only by patient study that all its parts can be properly referred. It is distinguished from *O. mirabilis* by its numerous arm-spines and by the different shape of the outer mouth-papillæ. It showed the same tendency to twist the arms upwards, above the disk.

By the kindness of Dr. Smitt and Mr. Ljungman, naturalists of the

* It will be noticed that the parts here called *outer tentacle scales* are, under *O. mirabilis*, Lym., termed *arm-spines*, because, in that species, they are continuous with the arm-spines and have the same shape. This is done to show that arm-spines and tentacle scales are homologous parts, and are differently named only to indicate their form or position.

Swedish frigate "Josephine," I was shown the Ophiuridæ dredged in 117 fathoms on the newly discovered Josephine Bank, southwest of Lisbon; and among them I recognized two fine specimens of *this very species!* We have, therefore, the same animal living on two sides of the Atlantic, and separated by nearly seventy degrees of longitude, but not yet discovered in the many deep dredgings made off the British and Scandinavian coasts.

Mr. Ljungman describes the color of the living creature as white underneath; yellow bars on the arms, two or four joints wide; a reddish spot at the insertion of each arm; a purple-gray, five-sided patch on the back of the disc. According to M. de Pourtales, the arms are white with an orange dorsal stripe; disk pink, with a greenish star; spines white, with orange specks at their bases.

ASTROPHYTIDÆ.

Ophiocreas Lyman, gen. nov.*

Disk and arms uniformly covered with soft skin bearing microscopic grains. Disk small; its interbrachial outlines re-enteringly curved; five pairs of narrow, rather high, radial ribs, running from the margin quite to the centre. Arms simple, very long and smooth; the joints indicated by very slight depressions. Small arm-spines standing just above the tentacles. Teeth: one or more tooth-papillæ; mouth-papillæ arranged in a clump on the side of the mouth-frame, and above its lower edge. Two genital slits, nearly as long as the disk is high.

This genus belongs to the Astrophytidæ, as the insertion of the arms in the disk, the character of the skin covering, and presence of radial ribs show; but in its chewing apparatus it presents more the characters of the Ophiuridæ. It stands near Astroschema, which, however, has no teeth.

Ophiocreas lumbricus Lyman, sp. nov.

Special Marks. — Radial ribs running quite to the centre of the disk. Two arm-spines, the lower longer. Arms gradually tapering, and nearly twenty times as long as the diameter of the disk. Skin beset with scattered microscopic thorny grains.

Description of a Specimen. — Diameter of disk 12 mm. Length of arm 230 mm. Height of arm near base 3 mm.; width of arm 2.5 mm. Mouth-papillæ nine or ten, forming a close, irregular clump of rounded grains on the side of the mouth-frame; none of them are as low as the under surface of the mouth, and are scarcely to be seen without forcing

* ὄφις, snake; κρέας, flesh.

is open. Teeth ten, very stout and uniform, except the lowest and uppermost, which are smaller; all are flat, a little longer than broad, with a curved outer edge, coming to a point on the median line, nearly of uniform thickness. Under the teeth are from one to three tooth-papillæ of irregular form. The joints of the arms are easily seen, even in alcoholic specimens, being marked by the interior bones, which are indicated through the skin. The arms themselves are high and arched; narrow below and divided into ridges by the bases of the spines; they are even and without depressions between the joints (except when the specimen is dried). The arms keep a uniform size for some time, and then taper very gradually. Arm-spines rounded, tapering, blunt, a little rough, but covered by the skin; there are two on nearly all the pores, but none on the first; one on the second and third, and two on the fourth, whereof the upper one is very small; lengths to that of the arm joint, 1.2, 2.2 : 1.5. At the tip of the arm both spines have three or four little hooks on their edge. Disk with five pairs of narrow, prominent, radial ribs, which diverge from the centre, where they meet, and run quite to edge, over the arms; the margins of the disk are re-enteringly curved, and its sides slope from the upper edge downwards towards the mouth region. The genital slits extend from near the upper edge of the disk to the mouth-ring below. Over the whole disk and arms are scattered microscopic thorny grains, which adhere lightly to a thin epidermal coat, which seems to carry the coloring matter. In alcohol the animal is of a dull flesh color, except the interbrachial spaces on the sides of the disk, which are purplish brown.

Variations. — A young one with a disk of 4.5 mm. had arms only one half as long as the specimen just described, to wit: 50 mm., from which it appears that the arms increase in a greater proportion than the disk. The teeth were only six; the grains of the skin were less thorny and more closely set than in the adult. Among many examined, the largest individual had the disk 17 mm. in diameter, and thirteen teeth, of which the two lowest were broken, so that each looked like two or three papillæ side by side; below these there was a small single papilla.

In 125 to 130 fathoms.

Astrophyton mucronatum Lyman, sp. nov.

Special Marks. — Radial ribs high, and beset with strong conical spines, a few of which are also found as far out as the third fork on the upper side of the arm. One madreporic body.

Description of a Specimen. — Diameter of disk 39 mm. Length of arm and distances of its forks from each other: —

1st	fork	to	2d	12	mm.
2d	"	"	3d	20	"
3d	"	"	4th	17	"
4th	"	"	5th	21	"
5th	"	"	6th	17	"
6th	"	"	7th	16	"
7th	"	"	8th	15	"
8th	"	"	9th	14	"
9th	"	"	10th	15	"
10th	"	"	11th	13	"
11th	"	"	12th	13	"
12th	"	"	13th	12	"
13th	"	"	14th	12	"
14th	"	"	15th	18	"
15th	"	"	16th	8	"
16th	"	"	17th	9	"
17th	"	"	18th	9	"
18th	"	"	end	16	"
	Total .	.	.	257	mm.

Teeth: tooth-papillæ and mouth-papillæ sharp, slender, spiniform; those standing in the place of teeth are about nine, arranged partly in a single, partly in a double vertical row; the longest 1.5 mm. Those near the outer corner of the mouth-slit are smaller, stouter proportionately, and irregularly crowded; length not over .5 mm. One madreporic shield, like a small pimple, about 2 mm. long, placed in a depression near the inner angle of the interbrachial space. Top and sides of arms, down to the tentacle scales, covered with a smooth mosaic of flat, irregular, rounded grains. Lower surface of arm, between the tentacle pores, smooth. Skin of the lower surface of the disk studded with flat, smooth grains, somewhat rounded; from six to nine to a square mm. but not confluent so as to form a mosaic. The space between the upper and lower surfaces of the disk is quite concave and very distinct, its skin being nearly naked and only covered by scattered microscopic grains. Whole upper surface of disk covered with a mosaic of grains like that of the arms; in addition to which the high radial ribs and the round space enclosed by the inner ends of the ribs, bear stout, smooth, conical spines, the largest 1.5 mm. high; of these there are ten or twelve to each rib, arranged in an irregular double row; those in the centre of the disk are crowded and smaller; the same spines form a row along the top of the arm, as far as the third fork; they are smaller than those of the disk, and there is usually one to each joint. Toward the end of arm each joint is marked by an annular ridge, which consists of a double row of grains, each bearing a mi-

nute, usually simple, sickle-shaped hook; these correspond to arm-spines, but gradually disappear towards the base of the arm, where, however, the double rows of grains are still to be recognized. Tentacle spines short, small, tooth-like; on most of the pores two, but some within the disk have three. Genital slits large, 10 mm. long, and extending from the under to the upper skin of the disk.

Variations. — Another specimen of about the same size had some small spines in the interbrachial spaces of the upper disk, and from nine to fourteen spines on each radial rib. On the under surface of the disk the granulation of the skin near the mouth was prolonged into the under surface of the arms, between the tentacle pores.

Florida, in 120 and 125 fathoms.

Astrogomphus Lyman, gen. nov.*

Disk with ten low, very narrow radial ribs, running nearly to its centre, and beset with numerous spines. Arms simple. Skin of arms and disk covered by a mosaic of small flat grains; the joints of the former distinguished by ridges, each of which consists of belts of granules, some of them bearing minute hooks. Arm-spines like thorny stumps, and arranged in clumps just above the tentacle pores. Teeth: tooth-papillæ and mouth-papillæ all similar and spiniform. Two genital slits in each interbrachial space.

Astrogomphus belongs with the simple-armed Astrophytons. In the distinctness of its disk, and the character of the surface of its arms, it somewhat resembles *Trichaster*, while its dentition is rather like that of *Astroporpa*.

Astrogomphus vallatus Lyman.

Special Marks. — The whole upper disk beset with short, very stout spikes, arranged rudely in concentric rows; under surface paved with smooth, flat grains, except a fence of stout papillæ, which runs between the lower sides of the arms, where they join the disk.

Description of a Specimen. — Diameter of disk 17 mm. Length of arm 100 mm. Width of arm next the disk 3.5 mm.; height of arm 3 mm. Mouth-papillæ and tooth-papillæ similar to each other, short, sharp, stout; mouth-papillæ about ten on each side, arranged in two irregular rows, one above the other; tooth-papillæ about twelve, arranged in irregular pairs along the point of the jaw; the longest are .8 mm.; and both mouth and tooth papillæ are spiniform, sharp, rounded, and perfectly smooth. Arms high and rounded above, flattened below; they are divided by depressions

* ἀστήρ, star; γόμφος, spike.

into joints, except on the lower surface, which is smooth, and is uniformly paved with small flat grains, looking, under the lens, like a rough mosaic. Each of the raised joints is covered by a belt of four rows of grains running across the arm; the two middle rows have smaller grains, each of which bears a little saw, having four or five teeth, and at its end a strong hook; the two outer rows have larger grains, without any appendages. Each depression between the joints is paved with two or three cross-rows of more or less flattened grains, similar to the smooth grains of the raised joints. Towards the end of the arm the raised joints consist only of the double row of grains bearing the saw-hooks. Disk, above, covered with a mosaic of smooth, flat grains, from which rise a great number of short, blunt, tapering, very stout spikes, the longest .8 mm.; they are arranged in about seven, more or less distinct, concentric circles, growing confused at the centre of the disk, where there is a space about 3 mm. in diameter, from the periphery of which spring the ten radiating ribs, which are very narrow, though somewhat broader over the bases of the arms; over these ribs run the circles of spikes, giving them a rough, spinous appearance. The interbrachial spaces below have a strikingly smooth appearance, though really covered with minute, rounded, flattened grains of several sizes. Between the bases of the arms, below, and connecting the first groups of arm-spines, runs a little fence of three irregular rows of little, crowded spikes, more blunt and rounded than those of the upper disk. Just outside one of these fences lies the madreporic plate, which is small and elongated, and has about a dozen large pores in an irregular row. The disk about the mouth is quite flat and smooth, so that the animal, seen from below, is laid out in regular patterns; in the centre the stellate mouth rough with spines; outside this a five-sided smooth region, which is prolonged on each arm; outside this a five-sided fence of spikes, which separates the mouth region from the interbrachial spaces, and is prolonged by the bunches of arm-spines along the side of the lower surface of each arm; again outside is the smooth interbrachial space, where the genital slits run from the edge of the disk (marked by a margin of spikes) about two thirds of the way to the interbrachial fence of spikes. Arm-spines equal, rounded, a little bent, suddenly contracting at the end, where they bear a bunch of four or five thorns; they are arranged side by side, in close clumps, at the angle made by the under surface and side of the arm; length of the longest, 1.2 mm. The first tentacle pore has one little simple spine; the second has four thorny spines; the third, and several beyond, five; then the number is four; towards the end of the arm it diminishes to three, two, and one. Near the tip, where there are but two, these spines have hooks at their ends, and at the very end there is but one spine, which is like the saw-hook borne by the grains on the back of the arm. Color in alcohol, yellow gray, or straw color.

Variations. — A smaller specimen, with a disk of 10 mm., presented no important differences. The spikes on the ribs of the disk were proportionately larger; the concentric circles of spikes were ill marked; the arm-spines were more thorny.

In 94 to 119 fathoms.

As this number of the Bulletin was going to press I received from Dr. Lütken his Additamenta ad Historiam Ophiuridarum, Part III, 1869, in which he enters into a critical discussion of the relations of the genera of Ophiurans. The work is done with that ability and thoroughness which usually characterize the Scandinavian naturalists above all others of Europe. This is not, however, the place to give a review of the paper, and I shall merely notice a few points that particularly concern the Caribbean fauna.

Two interesting genera are added to those known, from the West Indies, — *Ophionema*, which stands in the Amphiura group next to *Ophiopeltis*, from which it differs by having no disk scales at all, and by having all the arm-spines of the same form; and *Ophionephthys*, which is in the same group, and characterized by a disk covered partly by naked skin, while there is a frame of scales round each pair of radial shields, and a line of them along the edge of the disk. The species are *Ophionema intricata* and *Ophionephthys limicola*. There is also an *Ophiacantha* (*O. pentacrinus*) which, as the description will show, is very near to, if not identical with, my *O. meridionalis*. In treating of *Ophiactis clavigera* Ljn., Dr. Lütken has run against the precise difficulty I have (see *Ophiactis humilis*); and the anomalous position of the species is shown by the fact that, while he places it with *Ophiacantha*, I incline to retain it with *Ophiactis*. The real trouble is, that so many new forms are constantly discovered, that the limits of the old genera are as constantly found to be defective, particularly when those limits are established on characteristics more or less partial. For example, take Dr. Lütken's description of *Ophiactis*: "Squamæ disci spinulis brevibus plus minus obsitæ. Brachia 5 – 6 satis brevia. Spinæ laterales 5 – 7, papilla ambulacris 1, orales 1 – 2." Now, then, what is to be done with *O. plana*, that has *no* disk spines? Or what should we do with a species that had *two* tentacle scales, or *four* arm-spines? Or what is the meaning of "satis brevia," as applied to the arms? I am free to acknowledge that my own genera *Ophiophragmus* and *Ophiocnida*, among the *Amphiuræ*, could be catechized in like manner; but I do not see that *Amphipholis* Ljn. is a better substitute.* In fact, Dr. Lütken, with his usual modest judgment, alludes to the transition state of his classification when he says: "Je ne donte nullement aussi que

* See remarks on the genus *Amphiura*, p. 335.

des découvertes ulterieures ne conduisent à un système encore plus naturel et plus satisfaisant."

The *Ophiothrix violacea* of the Caribbean is said to be different from the similar form found on the coast of South Brazil. This is to be taken with great caution, considering that many Caribbean species go as far. Nevertheless, as pointed out in the Introduction to this Bulletin, there are *also* species apparently peculiar to the Brazil coast.

CAMBRIDGE, November, 1869.